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ABSTRACT

This technical paper is one of three produced by a large-scale effort aimed at implementing a new approach to measuring productivity, and using that approach to assess the impact of feedback, goal setting, and incentives on productivity. The productivity measurement system was developed for five units in the maintenance and supply areas at an Air Force base. The productivity measures derived from the system were used as the basis for formal feedback reports given to the units monthly for five months. After this, goal setting was added to the feedback for five months. Incumbents and supervisors of the five units jointly set goals each month. Finally, incentives were added to the feedback and goal setting. The results showed the approach to be a very effective method of productivity measurement and enhancement. Using the feedback produced by the system resulted in an average gain in productivity of 50 percent over baseline across the five units. When goal setting was added, the mean increase was 75 percent over baseline. When incentives were added to that, the mean increase was 76 percent over baseline. The positive effects lasted over time and continued after the departure of the research team. It was concluded that feedback increased productivity substantially, goal setting increased productivity further, and incentives did not add anything to this. The productivity measurement system and resulting feedback and goal setting systems show great promise for future Air Force use. (KC)

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FEEDBACK, GOAL SETTING, AND INCENTIVES EFFECTS ON ORGANIZATIONAL PRODUCTIVITY

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Good measures of productivity are necessary components of Air Force efforts to enhance productivity. It is also important that different methodologies to enhance productivity be evaluated in Air Force environments. The techniques of feedback, goal setting, and incentives are methodologies that have shown good potential, and merit such evaluation. Once the productivity measurement system was developed, it became the basis for providing formal monthly feedback to personnel and management about unit productivity. Goal setting and incentives were added to feedback. Measures evaluating the effectiveness of the approach were taken during the development and implementation periods. Both productivity and attitudes were measured. The system was developed for five units in the maintenance and supply areas at an operational Air Force base. After development, the measurement system was used as the basis for formal feedback that each unit received every month for 5 months. Next, goal setting was added to the feedback for another 5 months. Incumbents and supervisors jointly set productivity goals for the following month. Finally, incentives in the form of time off were added to feedback and goal setting. Units could receive a half or a full day off each month, depending on their productivity. The results showed the system to be a very effective method of productivity measurement and enhancement. Its implementation was effective, unit

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personnel were cooperative in developing and using it, and it showed good psychometric characteristics. Compared to the baseline period, the feedback produced by the system resulted in an average gain in productivity of 50% during feedback, 75% during the feedback plus goal setting intervention, and 76% when incentives were added. The positive effects lasted over time, and continued after the departure of the research team. The incumbents and supervisors of the units evaluated the system very positively. The managers of the units have continued the system on their own, and have requested that it be used in other units at the base. The productivity measurement approach used in this effort proved very effective for Air Force organizations. Using the measurement system to provide feedback improved productivity greatly. Goal setting increased productivity beyond feedback, but due to the probable continuing effects of feedback, the goal setting effect may not have been very large. Incentives did not add meaningfully to productivity. Different work attitudes under the system were either as good or better than before the program. The productivity measurement system has a number of advantages. For example, it can be applied to any level of the organization, allows different units to be combined into one measurement system, and allows for direct comparison of the productivity of different units. The productivity measurement system and resulting feedback and goal setting systems show great promise for future Air Force use.

SUMMARY

This report describes a field test of a new approach to measuring organizational productivity and its use in the implementation of feedback, goal setting, and incentive systems.

The productivity measurement system was developed for five units in the maintenance and supply areas at an operational Air Force base. The productivity measures derived from the system were used as the basis for formal feedback reports given to the units monthly for five months. After this, goal setting was added to the feedback for five months. Incumbents and supervisors of the five units jointly set goals each month. Finally, incentives were added to the feedback and goal setting. The incentives were time off from work, and units could earn either a half or a full day off, depending on their productivity.

The results showed the approach to be a very effective method of productivity measurement and enhancement. It also has several other advantages such as aggregating qualitatively different units into one productivity measure, and allowing for direct comparison of productivity across different units. Using the feedback produced by the system resulted in an average gain in productivity of 50% over baseline across the five units. When goal setting was added, the mean increase was 75% over baseline. When incentives were added to that, the mean increase was 76% over baseline. The positive effects lasted over time, and continued after the departure of the research team. The units have continued the system on their own, and their managers have requested that it be used in other units at the base.

It was concluded that feedback increased productivity substantially, goal setting increased productivity further, and incentives did not add beyond this. The goal setting and incentive conclusions were somewhat tentative due to the probable presence of learning and ceiling effects. Different work attitudes under the program either improved or were unchanged. Conclusions about developing productivity systems in Air Force environments were discussed.

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I. INTRODUCTION

The problem of enhancing productivity has been a universal concern for some time. Enhancing productivity has implications for our quality of life, our economy, and our competitive position in the world marketplace (Alluisi & Meigs, 1983; American Productivity Center, 1981). In addition, individual organizations are continually concerned about increasing their productivity in order to improve their operational effectiveness. This concern for increasing productivity is shared by the Air Force, and has led the Air Force Human Resources Laboratory (AFHRL) to explore ways of enhancing productivity through research and development (R&D) efforts in the productivity domain.

The present R&D effort was a large-scale field effort aimed at implementing a new approach to measuring productivity, and using that approach to assess the impact of feedback, goal setting, and incentives on productivity. This technical paper is one of three produced by the effort, and describes the entire project and its results. A second technical paper from the project, entitled "Organizational Productivity Measurement: The Development and Evaluation of an Integrated Approach" (Pritchard, Jones, Roth, Stuebing, & Ekeberg, 1987a), presents a more detailed description of the development and evaluation of the productivity measurement system used in the effort. Although there is some overlap between the two papers, this one is designed to present the entire project, whereas the second focuses primarily on the productivity measurement system itself. The third paper resulting from the project is quite different in nature. It is non-technical and designed to aid operational managers in designing and implementing feedback, goal setting, and incentive systems. It is entitled "Manager's Guide to the Implementation of Feedback, Goal Setting, and Incentive Systems" (Pritchard, Jones, Roth, Stuebing, & Ekeberg, 1987b).

In the present paper, we shall (a) briefly review the literature on feedback, goal setting, incentives, and productivity measurement; (b) describe the methods and procedures used in the research; (c) describe the results of the effort; (d) discuss and interpret the results; and (e) draw conclusions.

II. REVIEW OF THE LITERATURE

Feedback

The positive effect of feedback on performance has become one of the most accepted principles in psychology (see reviews by Ammons, 1956; Annett, 1969; Bilodeau & Bilodeau, 1961; Guzzo, Jette, & Katzell, 1985; Ilgen, Fisher, & Taylor, 1979; Nadler, 1979; Sassenwrath, 1975; and Taylor, Fisher, & Ilgen,

1984). Of particular interest to organizational researchers is the host of studies that have demonstrated the beneficial effects of feedback on individual performance in organizations (e.g. Dockstader, Nebeker, & Shumate, 1977; Ilgen, Fisher, & Taylor, 1979; Ivancevich & McMahon, 1982; Pritchard, Bigby, Beiting, Coverdale, & Morgan, 1981). Although most of the feedback research has focused on the impact of feedback on individual performance, feedback has also been shown to increase the productivity of groups (e.g. Becker, 1978; Chobbar & Wallin, 1984; Nadler, 1979).

Because this technical paper concerns productivity enhancement, the review of the feedback literature will focus primarily on the type of feedback that has been or could be used in organizations. Feedback in organizations consists primarily of three types: (a) feedback to the organization about organizational processes and attitudes (e.g., survey feedback); (b) performance appraisal feedback; and (c) regular feedback about some form of output, such as units completed or number of safety violations per month. This review will focus primarily on this third type of organizational feedback while including relevant contributions from research on the first two types of feedback where appropriate.

Aside from establishing that feedback works, feedback research has principally followed three lines of inquiry. The first involves investigating the different dimensions of feedback and how a feedback system should be designed along those dimensions so that it can have optimal effect. The second line of research has been to examine the effects of moderator variables on these dimensions. The third area of inquiry has been be to examine the processes or mediating mechanisms through which feedback affects performance.

Research on Feedback Dimensions

Types of feedback can be described along a series of dimensions. Different types of feedback may have different effects, and the effects of feedback may be optimized by understanding these different dimensions. Examples of dimensions of feedback that have been investigated are: source of the feedback (Fisher, 1979; Greller, 1980; Greller & Herold, 1975), positive versus negative feedback (Fisher, 1979), immediate versus delayed feedback (Beeson, 1973; Christian, 1972; Robinson & Kulp, 1970; Sassenwrath & Younge, 1969), knowledge of right versus wrong responses (Longstreth, 1970; Merrill, 1970; Wike, 1970), verbal versus non-verbal feedback (Lair & Smith, 1970; Simpson, 1972), personal versus impersonal feedback (Pritchard, Montagno & Moore, 1978; Weidner, 1968), accurate versus inaccurate feedback (Griswold, 1970), information content

(Berman, Fraser, & Theious, 1970), and frequency of feedback (Chobbar & Wallin, 1984; Ivancevich, Donnelly, & Lyon, 1970).

Greller (1975) focused on the sources of feedback in organizations and proposed a four-dimension feedback source taxonomy. The four dimensions were consequences from agents, expressions from agents, task feedback, and internal comparisons. Internal comparisons arise from the comparisons one makes between one's self and others on the same job. Beyond these four dimensions, Greller proposed that an evaluative continuum exists along each of these four dimensions. When Greller tested this model, he found partial support, but found that positive and negative feedback were not simple opposites. Building on this line of research, Greller and Herold (1977) reported on a factor analysis of questionnaire data. They reported the following five factors: negative feedback independent of source, positive feedback from superiors, positive feedback from non-hierarchical others, internal criteria, and work flow feedback.

Pritchard and Montagno (1978) reviewed the literature and listed 14 feedback dimensions, which can be summarized as follows:

1. **Positive versus negative feedback.** Feedback can be given for correct behavior (or high performance) and/or for incorrect behavior (or low performance). The first is positive feedback; the second is negative feedback.
2. **Timing of feedback.** Refers to the delay between performance and the presentation of feedback.
3. **Specificity.** Refers to the molecularity of the behavior for which feedback is given.
4. **Evaluative - Non-Evaluative.** The feedback may be purely descriptive or it may contain an evaluative component.
5. **Absolute - Comparative.** The feedback may be information about the recipient's performance (absolute), or may also provide information about performance relative to some set of norms or to the performance of other recipients.
6. **External - Internal.** Refers to the source of the information. Internal feedback is based on the person's own experience with the task. External feedback comes from sources outside the person.
7. **Personal - Impersonal.** Concerns the level of personal contact between the source and the recipient.
8. **Power of Source.** Refers to the degree to which the source controls the recipient's rewards.
9. **Schedule of feedback.** The feedback may be continuous, or it may be given at fixed intervals or variable intervals.

10. **Group - Individual.** The feedback may be provided at the individual or group level.
11. **Comprehensiveness.** Refers to the percentage of the recipient's role that is covered by the feedback.
12. **Formal - Informal.** Concerns the manner in which the recipient is given feedback (e.g., written vs. verbal comment).
13. **Public - Private.** The feedback may be given to the recipients alone or shared with other members of the organization.
14. **Accuracy.** Refers to the extent to which the feedback reflects the true performance of the recipient.

Pritchard and Montagno (1978) examined the absolute-comparative and the specificity dimensions with simulated inventory control jobs. Non-specific feedback was operationalized as the number of processed orders with one or more errors; specific feedback gave information on the type of errors made. Non-specific feedback was superior to specific feedback in terms of increasing performance. Within the non-specific condition, comparative feedback was superior to absolute feedback; there was no difference in absolute versus comparative feedback within the specific condition.

Following this same line of research, Pritchard, Montagno and Moore (1978) examined the effects of six feedback dimensions in a job simulation experiment. Impersonal feedback was found to be superior to personal feedback. High specificity was superior to low specificity feedback. Performance was equally improved by group and individual feedback. Public versus private feedback showed no differential effect. The authors concluded that the best combination of feedback procedures in this study was impersonal, high specificity, individual feedback in either a public or private format. This combination produced a 26% increase in quantity and a 27% decrease in errors.

Continuing this series of feedback studies, Pritchard, Bigby, Beiting, Coverdale, and Morgan (1981) varied the personal-impersonal and absolute-comparative dimensions in a field study. They held constant the remaining dimensions so that the feedback was specific, individualized, private, comprehensive, formal, external, and accurate. The feedback did not contain an evaluative component, but simply reflected the performance levels of the individual incumbents. Results indicated that feedback significantly improved performance both in terms of quantity and quality. The authors concluded that there were no differences between impersonal and personal feedback, nor were there any differences between absolute and comparative feedback. Thus, they concluded that the choice of which type of feedback to use should best be determined by the particular

circumstances and preferences of the unit to which the feedback would be applied.

Payne and Hauty (1955) reported that specific feedback, which they termed "directive feedback," increased motor performance over less specific feedback. They also found that global, comparative feedback, which they called "incitive feedback," was superior to global, absolute feedback.

Dockstader, Nebeker, and Shumate (1977) compared absolute and comparative feedback. They found that comparative feedback was superior to absolute feedback on quantity measures using keypunch operators. They theorized that comparative feedback facilitated the setting of implicit goals by the operators.

In examining the effects of feedback frequency, Chobbar and Wallin (1984) varied the frequency of feedback about safety violations in a manufacturing plant. They found that frequent feedback (once a week) was no more effective in increasing safety performance than was less frequent feedback (once every two weeks). Examination of the safety performance data indicates there may have been a ceiling effect operating so that there was no opportunity for the more frequent feedback to show a difference. Both feedback conditions significantly improved safety performance over baseline levels.

Greller and Herold (1975) reported that the more proximal the source of the feedback, the greater the utilization of the feedback. As one indication of this, an individual's own feelings and feedback from the task were reported as the most commonly used sources of feedback.

As a whole, these studies do not identify the characteristics of the optimal feedback system. They do show that a variety of feedback approaches work. This overall finding is quantified by the meta-analysis of Guzzo, Jette, and Katzell (1985). Their results indicate that there is a significant effect on performance due to feedback interventions across a variety of situations. The authors determined that the mean effect size for feedback interventions (including performance appraisal) is .5 standard deviations.

Moderators of the Feedback-Performance Relationship

Moderators of the feedback-performance relationship are used to explain why a feedback effect may exist, or why it is stronger in one condition than it is in another. One of these moderator variables is the initial level of performance or motivation of the recipients. Berkowitz, Levy, and Harvey (1957) found that initial motivation of the recipients affects the task-oriented behavior

following feedback. Initial high motivation individuals exhibited more task oriented behavior than did low motivation individuals after negative feedback. After positive feedback, initial low motivation individuals became more task-oriented.

Ilgen, Fisher, and Taylor (1979) reviewed the feedback literature and developed a model of the feedback process. Their model allows for individual differences to impact the feedback process at four points: perception of the feedback, acceptance of the feedback, desire to respond to the feedback, and intended response. They concluded that personality variables create a frame-of-reference that causes the feedback to be interpreted so that it is consistent with the recipient's self-image. Thus, persons with high self-esteem rely less on feedback from the job environment and more on their own self-perceptions to guide their work behavior than do people with low self-esteem (Weiss, 1977). In a related fashion, subjects with an internal locus of control perform better when the feedback originates directly from the task itself, whereas those with an external locus of control perform better when a person (e.g., an experimenter or supervisor) provides the feedback (Baron, Cowan, & Ganz, 1974; Baron, Cowan, Ganz, & McDonald, 1974; Baron & Ganz, 1972).

Feedback Mechanisms and Processes

Research on feedback has also explored how feedback works. In their review of the feedback literature, Ilgen, Fisher and Taylor (1979) commented on the large number of studies relating dimensions of feedback to responses, with little attention to the mediating psychological processes. Locke and Bryan (1969) noted the same gap ten years earlier: "the question of how KR [knowledge of results] facilitates performance has not yet been answered" (p. 89).

Several researchers have offered ideas concerning how feedback influences performance. Ammons (1956) suggested three mediating effects of feedback which have been elaborated by others (e.g. Becker, 1978; Chapanis, 1964): (a) Feedback informs the recipients about their performance in terms of extent and type of performance, (b) feedback rewards or punishes the recipient for acceptable or unacceptable performance, and (c) feedback may motivate the recipient through intrinsic means.

Several researchers have examined the motivating effect of feedback. Gibbs and Brown (1955) reported that subjects who received absolute feedback about the number of units finished increased performance. The explanation was that the information provided led the subjects to compete against themselves. Chapanis (1964), however, found he could not replicate these results for a similar task.

Locke and his associates have argued that the motivational effect attributed to feedback is actually due to goal setting (Locke, Cartledge, & Koeppel, 1968). According to this view, feedback will have a facilitating motivational effect only when it leads to the setting of a difficult performance goal. This implies that feedback is a necessary but not sufficient condition for improved performance. There is some supporting research for this proposition (Becker, 1978; Erez, 1977; Locke & Bryan, 1968; Locke, Shaw, Saari, & Latham, 1981; Shaw, Locke, & Bobko, 1981).

It should be noted, however, that Locke views conscious intentions as goals. That is, if an individual decides that he/she will attempt to produce 100 units, this is goal setting. Locke's position is that this goal setting must occur for feedback to have a positive effect on performance. This is quite different than saying there must be a formal goal setting program for feedback to affect performance. It is very clear that feedback alone can have powerful effects on performance. Thus, the issue that the above literature addresses is whether a person must have a conscious intention of performing at a given level in order for feedback to work.

Following the logic that feedback should lead to goal setting, Bigby (1981) and Morgan (1984) surveyed participants in a field experiment where feedback resulted in improved performance (Pritchard, Bigby, Beiting, Coverdale, & Morgan, 1981). Bigby (1981) reported non-significant decreases in personal goal setting from baseline to feedback. Morgan (1984), using a regression analysis, found that personal goal setting predicted only one of four performance measures.

Pritchard and Montagno (1978) proposed four mediating mechanisms to explain the effects of feedback on performance: (a) improved role clarity, (b) expectancy-instrumentality-valence effects, (c) implicit goal setting, and (d) direct effects on intrinsic motivation. The authors tested all of these mechanisms except implicit goal setting, but found none of the hypothesized changes even though performance did increase as a result of feedback.

The Ilgen, Fisher, and Taylor (1979) model emphasized characteristics of the feedback and the recipient which influence several aspects of the feedback situation. These include the perception and acceptance of the feedback by the recipient; the desire of the recipient to respond to the feedback; the intended response of the recipient; and finally, the eventual response of the recipient. Research has supported portions of this model (e.g., Vandaveer, 1981). However, since the model is intended primarily to explain the performance appraisal

feedback process, its contribution is limited in explaining feedback of the type with which we are concerned here.

Nadler (1979) proposed a preliminary model of the effects of feedback on group task behavior. Building on propositions by Payne and Hauty (1955) and Vroom (1964), and a model developed by Hackman and Morris (1975), Nadler proposed a model of group performance as it is affected by feedback. Nadler reviewed 34 studies, most of which indicated that feedback can improve group functioning through a cueing function, a motivational function, or a combination of the two.

Nadler proposed that the variables of aggregation of the feedback (group or individual), focus of the feedback (task or process), and the evaluative content of the feedback (positive or negative) exert their effects through the cueing or motivating functions but that the effects of these variables are contingent on a number of factors. He suggested that the effect of level of feedback aggregation on groups is contingent on: (a) the desired impact of the feedback (i.e., affective, cognitive, or behavioral), (b) the nature of the group task, and (c) the characteristics of the group members. He found that group-level feedback enhanced group attitudes and task motivation, but that individual feedback was more effective in enhancing individual performance. For the second factor, he found that group feedback was more effective when interdependent tasks were performed by the group and that individual feedback was more effective where group performance was simply the sum of individual performances. For the third factor, characteristics of group members, he found that affiliation-oriented individuals were more responsive to group-level feedback than were non-affiliation individuals.

Nadler also examined the effects of the evaluative content of feedback on group performance. He concluded that evaluative feedback does lead to "changes in member motivation, creation of attributes (including defensive coping) and changes in patterns of group interaction or structure." Negative group-level feedback is said to have an unclear pattern of effects on group performance, since it evokes coping behaviors (Zander & Wulff, 1966) and external attributions to the causes of the group's poor performance (Schlenker, Soraci, & McCarthy, 1976) and may also result in the lowering of group aspirations (Dustin, 1966).

Taylor, Fisher, and Ilgen (1984) reviewed research on individuals' reactions to feedback taking a control theory approach to explain how feedback influences performance. They discussed the issue of discrepancies between employees' performance standards and the organization's performance standards and argued that if feedback is to have the impact intended by a source, there must be

high congruence between behavioral standards and performance dimensions included in the feedback.

They suggested four causes of differences between these sets of standards. First, feedback recipients may lack standards to guide their behavior on the job. Second, recipients' standards for behavior may be qualitatively different from those of the organization. Third, recipients may have a different priority system for standards than the organization does. Fourth, there may be quantitative differences in the level of standards held by the the source and the recipient.

These differences in standards represent a major issue to be addressed in developing a feedback system. This is a particularly sensitive issue where the feedback system contains standards or an evaluative dimension. A system that does not reach some resolution of conflicts between these standards may not be very effective.

Taylor et al. (1984) discussed the effects of feedback on goal levels. They cited evidence that goals change in response to feedback in the following ways: (a) Feedback produces variance in participants' goals. (b) Long-term negative feedback may lead to reduced goals; however, the level of sub-goals may be increased in response to negative feedback. (c) Positive feedback may influence standards by increasing them, decreasing them, causing them to remain constant, or changing their nature. Positive feedback may increase performance when there is no obvious payoff associated with surpassing standards as opposed to merely meeting them. Standards may also be increased following positive feedback (Campion & Lord, 1982). Goals may also remain stable after positive feedback (a type of "keep up the good work" attitude). The nature of standards may also change through the alteration of strategies.

Taylor et al. also looked at the potential behavioral responses to feedback. Reminiscent of the cueing function and motivating function of Payne and Hauty (1955) and Nadler (1979), they looked at the effects of feedback on the direction of behavior. They concluded that negative feedback seems to initiate a search for alternative work strategies. In addition, they suggested that negative feedback may decrease effort when the expectancies are low. The authors also examined potential responses against the feedback system. Even when feedback is perceived as fair, it may provoke a response of "psychological reactance," which is a desire to reassert control when one's freedom of choice is threatened (Brehm, 1966; Brehm & Brehm, 1981). This concept of reactance may help to explain why unilateral, critical, or directive performance appraisals and feedback

systems are less effective than more participative appraisal and feedback systems (e.g., Bassett & Meyer, 1968; Kay, Meyer, & French, 1965).

Goal Setting

The benefits of combining goal setting with feedback to enhance performance or productivity have been well established in a wide variety of situations (see reviews by Latham & Yukl, 1975; Locke, 1968; Locke, Shaw, Saari, & Latham, 1981; Steers & Porter, 1974; and Tubbs, 1986). Goal setting has been effectively used with a variety of jobs such as production workers (Dachler & Mobley, 1973); telephone operators (Burke & Wilcox, 1969); logging crews (Latham & Yukl, 1975); Navy industrial workers (Crawford, White, & Magnusson, 1983); clerical workers and keypunch operators (Dockstader, Nebeker, & Shumate, 1977; Pritchard, Bigby, Beiting, Coverdale, & Morgan, 1981); truck drivers (Latham & Baldes, 1975) and engineers (Ivancevich & McMahon, 1982). In a meta-analysis of psychologically based interventions (Guzzo, Jette, & Katzell, 1985), goal setting was found to have an average effect size of .8 standard deviations.

Goal setting research has primarily followed the same avenues that have been explored in the research on feedback: the dimensions of the goal setting effect, possible moderators, and the process or mechanisms whereby the effect occurs.

Dimensions of Goal Setting

As mentioned, research has explored the dimensions of goal setting to determine how goals should be set for maximum effectiveness. These dimensions are: goal difficulty, goal specificity, and participation in the setting of the goal. Research results convincingly demonstrate that challenging and specific goals result in better performance than do easy goals, no goals, or vague "do your best" goals (Locke, Shaw, Saari, & Latham, 1981; Tubbs, 1986). Additionally, there appears to be a positive, linear relationship between goal difficulty and performance, provided the goal has been accepted (Erez & Zidon, 1984). Locke, et al (1981) concluded that the necessity of participation in the setting of the goal is unclear. They reviewed a series of studies that demonstrated that when the level of goal difficulty is the same for participatively and non-participatively set goals, there is no difference in performance. Tubbs, however, in his meta-analysis found a weak but positive effect size for participation. Furthermore, Locke et al. (1981) suggested that participation may have subtle effects on such outcomes as supervisory support, as well as improved understanding of goals and how to reach them. In addition, it was found that participatively set goals tend

to be set higher than non-participatively set goals (Latham, Mitchell, & Dossett, 1978) and thus tend to lead to higher performance.

Moderators of the Goal Setting-Performance Relationship

Several moderator variables have been studied for their effects on the goal setting-performance relationship. The following moderators have received empirical support (Tubbs, 1986):

1. Laboratory versus field setting. Goal setting demonstrates a stronger effect in the laboratory than in actual organizations.

2. Presence of and formality of feedback. Specific goals and participatively set goals are more effective when feedback is present and is formal rather than informal.

3. Quantity goal versus time goal. Goal setting has a stronger effect when the goal is in terms of quantity rather than time.

Goal Setting Mechanisms and Processes

According to Locke's (1968) theory, a goal is a mental event that is simply what the individual consciously intends to accomplish. The theory assumes that conscious intentions regulate actions, and furthermore that goals are the immediate regulators of action. Because goals are seen as the immediate regulators of action, there are no cognitive mediating mechanisms proposed by Locke and associates to explain how goal setting works. Instead, the mediating mechanisms are seen as actions that occur between the establishment of the goal and the final targeted performance level. These mechanisms are indicated below.

1. Direction (of behavior). When goals are established, the goal-relevant areas of performance are attended to more than are non-goal-relevant areas of performance.

2. Effort. Goals result in higher performance because people work harder than if there are no goals, and they work even harder when the goals are harder.

3. Persistence. This mechanism is simply a combination of direction and effort over time.

4. Strategy Development. People with goals are likely to develop action plans or to improve strategies for achieving their goals.

In their review, Locke, et al. (1981) cited evidence supporting these four mechanisms. Support appears weakest for the Effort and the Persistence mechanisms, while the Direction and the Strategy Development mechanisms have been more thoroughly researched.

Naylor and Ilgen (1984) reviewed the mechanisms proposed by Locke et al. (1981) and concluded that the mechanisms were quite complex and required somewhat ambiguous sub-constructs. Therefore, they proposed mechanisms for goal setting that were derived directly from the organizational theory proposed by Naylor, Pritchard, and Ilgen (1980), and showed how different types of goal setting would be explained by the theory. Although testing of some of their propositions may be difficult, Naylor and Ilgen make a persuasive argument for employing these very precise concepts in explaining how goal setting works.

Incentives

The use of incentives to alter motivation and behavior has been researched for over half a century (Hull, 1943; Lewin, 1938; Skinner, 1938; Thorndike, 1911; Tolman, 1932). Incentives have been used in almost every conceivable situation where a behavior is to be enhanced. Reviews of incentive motivation theories may be found in Campbell and Pritchard (1976); DeLeo (1972); Guzzo (1979); and Lawler (1971). Although most formal reward systems in organizations employ financial incentives, motivation theories hold that behavior can be motivated by a variety of rewards including pay, praise, promotion, recognition, time-off, social freedom, self-development, alleviation of boredom, sense of accomplishment, etc.

Although the effectiveness of incentives has been well established in the psychological and management literature, only 26% of U.S. workers are covered by formal incentive plans aimed at enhancing productivity (Fein, 1976). Incentive programs are more prevalent in manufacturing firms (59%) than in non-manufacturing firms (6%) (Rice, 1977). Federal sector organizations, which have less freedom in allocating funds for programs such as incentives, reportedly spent only .1% of the Federal payroll for cash incentive awards in fiscal year 1978. Only this small amount was spent, even though the savings to the Government were estimated to average $11 for every $1 spent on incentive awards (Spector & Hayes, 1979).

Taylor (1947) was the first to write about the use of incentives in organizations. He argued that people will work harder when their rewards and punishments are directly tied to their performance. In addition to the requirement of a perceived link between incentives and performance, the rewards must be perceived as worthwhile and valuable if they are to be effective incentives (Lawler, 1973). Also, the performance goals for achieving the incentives must be perceived as attainable if the incentives are to have the desired effect. Much theoretical and empirical work on expectancy theory has refined these ideas (Campbell & Pritchard, 1976; Lawler, 1973; Mitchell, 1974).

The better the employee understands the relationship between delivery of incentives and performance, the more effective the incentive system will be (Opsahl & Dunnette, 1966). A mass of evidence supports this proposition (Arvey, 1972; Atkinson, 1958; Atkinson & Reitman, 1956; DeLeo, 1972; Evans, 1970; Galbraith & Cummings, 1967; Gavin, 1970; Graen, 1969; Hackman & Porter, 1968; Jorgenson, Dunnette, & Pritchard, 1973; Lawler & Porter, 1967; Porter & Lawler, 1968; Pritchard & Sanders, 1973). For example, Georgopoulos, Mahoney, and Jones (1957) reported that workers who perceived higher personal productivity as a means to increased earnings were more productive than workers who did not perceive such a relationship.

The clarity of this relationship may be diluted in various situations. Campbell (1971) reported a negative relationship between group size and clarity of the relationship between pay and productivity. Lawler (1964) reported that, on the average, managers saw no relationship between their performance and their pay, although highly motivated managers did see such a relationship.

The importance of the perceptions of rewards in determining their effect on motivation can be seen in the common example of the supervisor giving praise to the subordinate. If the subordinate perceives the praise as condescending, insincere, or a tactic of ingratiation, the praise may have the opposite of the effect intended.

Incentive Systems in the Military

Wood, Hakel, DelGaizo and Klimoski (1975) reported on the attractiveness and feasibility of using social incentives in Air Force technical training. Their factor analysis revealed that recognition was the most attractive dimension, followed by personal freedom, self-development, social behaviors (such as social interaction, being concerned for helping the instructor, etc.), and information feedback (such as information on military assignments, or feedback on strengths and weaknesses). The more attractive incentives were those having a direct

impact on the trainee; these incentives tended to be more costly and had low administrative feasibility. The authors proposed four experimental social incentive systems, of which two were individual incentive systems and two were group incentive systems. Within each of these categories, the incentive systems were divided into systems administrated by the training instructor or by the instructor and the class. The rationale for proposing group incentives was that performance in training was felt to be affected by the development of cohesiveness in the class and by class members helping each other reach performance standards.

Several researchers have reported on the use of incentives to increase performance in the military (Cassileth, 1969; Datel, 1970; Datel & Legters, 1970-1971; Dockstader, Nebeker, & Shumate, 1980; Dockstader, Nebeker, Nocella, & Shumate, 1980; Korman, Glickman, & Frey, 1981; Pritchard, Von Bergen, & DeLeo, 1974). In general, the results demonstrate that the effectiveness of incentives is highly variable. Korman, et al. (1981) found that disposition to enlist was not related to the amount of the incentive. Pritchard, et al. (1974) found that high-feasibility incentives (letters of commendation, time-off, avoidance of work details, choice of uniform, and avoidance of marching in formation) were not effective in increasing performance. Pritchard, et al. also found that financial incentives were effective only with one of their two experimental groups. Cassileth (1969) found that incentives of 3-day passes and free movies were effective only in increasing performance for high ability trainees; they had no effect for low ability trainees.

These results from the military setting are consistent with those of a meta-analysis of intervention programs which found that financial incentives have a broad range of effects (Guzzo, Jette, & Katzell, 1985). These authors reported an average effect size of .57 standard deviations (d-statistic) with a broad confidence interval that also included zero (-.10 to 1.24). They concluded that "the effects of incentive programs depend heavily on the circumstances and methods of applying them and ... on the criterion of productivity" (p. 285). When the criteria of productivity were broken down into output (which included quantity and quality of production), withdrawal, and work disruption, the effect size of financial incentive programs was significantly different from zero for the output criteria only.

Conclusions from the Literature on Feedback, Goal Setting and Incentives

It is clear from the literature that feedback can have a positive effect on individual performance. What literature exists also indicates that feedback can enhance group performance. However, most of this research has dealt with jobs that were quite simple. Usually, everyone did the same work, everyone worked

independently, and there were one or two easily collectible objective measures of performance. When we apply these findings to Air Force environments, there is a very important difference. The vast majority of Air Force jobs are much more complex than those documented in the literature. This complexity exists because (a) these jobs involve individuals doing many different things, (b) coordination among individuals is a crucial part of the jobs, and (c) objective measures are not generally available.

This suggests that to use feedback techniques in Air Force environments, we must develop ways of providing feedback for these complex jobs. This means that we must first develop measures of productivity that are applicable to complex, interdependent jobs and combine them with techniques of giving feedback that are effective for such jobs.

The same general line of reasoning applies to goal setting and incentives. Both can be effective. But it is not clear whether the positive effects will also occur in a military setting for the type of complex jobs typically found in Air Force organizations.

Organizational Productivity

Although much has been written on the subject of organizational productivity, there is little consensus concerning its definition (Tuttle, 1983). This lack of consensus is perhaps not surprising, since there are many approaches to and perspectives on productivity. However, several major issues are cited throughout this literature, and these will be addressed here.

The first issue to be addressed is whether an efficiency or an effectiveness approach should be used in measuring productivity. Both have been proposed and used. Efficiency is typically thought of as an output-to-input ratio. For example, monthly manufacturing output divided by manpower used to produce that output would be an efficiency measure. Effectiveness is usually defined as the relationship of outputs to some standard or expectation. For example, monthly manufacturing output expressed as a percentage of the goal for that month would be an effectiveness measure. In addition, effectiveness usually includes quality of the output as well as quantity.

Efficiency is the more widely used of the two concepts since it is easier to measure and standardize across organizations, industries, and nations (Norman & Bahiri, 1972). When we hear that productivity growth in the United States has declined over the last 20 years (American Productivity Center, 1981), it is an efficiency ratio that is being quoted (i.e., price deflated gross national product

divided by worker hours). Effectiveness is a much broader concept because it includes other factors such as standards, objectives of the organization, expectations of interested parties (e.g., shareholders, regulatory agencies, and customers), and the viability of the organization relative to its competition. Proponents of the effectiveness concept argue that as the complexity and ambiguity of the work increase, effectiveness measures become more important than efficiency measures (Balk, 1975). Some authors define productivity as a combination of efficiency and effectiveness (Balk, 1975; Coulter, 1979; Hanes & Kriebel, 1971; National Center for Productivity and Quality of Working Life, 1978; Sibson, 1976; Tuttle, 1981).

A second issue is what perspective should be taken in measuring productivity. The literature indicates that the approach to be used in measuring productivity is determined by the perspective of those doing the measuring. Tuttle (1983) suggests five perspectives: those of the economist, engineer, accountant, manager, and industrial/organizational psychologist. These approaches differ primarily in what they are trying to learn from the productivity measurement. To the economist, for example, productivity is output divided by associated inputs such as labor, capital, intermediate products purchased, and time. This approach is typically applied to very macro units such as whole industries or countries to measure the economic health of those units. The industrial/organizational psychologist approach focuses on the the personnel subsystem of the organization, and its measures deal with the efficiency or effectiveness of the personnel. These approaches are quite different. They measure different things, and they are used for different purposes. They would also result in very different productivity measurement systems.

The next issue is what measures should be included in the measure of productivity. Clearly, the different perspectives such as the economist's and the accountant's have implications for what measures are included. There are, however, a variety of other possibilities. Campbell (1977), for example, listed 30 types of measures that have been used. These included the expected measures such as effectiveness, efficiency, profit, and quality, but also included measures such as absenteeism, growth, morale, control, internalization of organizational goals, evaluations by external entities, and stability. As another example, Seashore and Yuchtman (1967) reported a factor analysis of organizational productivity scores for insurance agencies. They identified ten factors, many of which were quite different from those listed by Campbell. They included new member productivity, youthfulness of members, business mix, manpower growth, and market penetration.

The variety of measures that could be included in a productivity measurement system clearly shows that there is no one set of measures that best defines productivity. The diversity of possible measures must be considered in the design of a productivity measurement system.

Apart from the issue of what productivity is, there is considerable agreement that a productivity measurement system should include all important aspects of the organization's work. If the system is not complete, it could easily encourage neglect by the organization's personnel of those organizational objectives which are not part of the measurement system. In such a situation, the actual overall effectiveness of the organization would suffer (Duerr, 1974).

Another broad issue is whether or not the productivity measurement system should provide an overall index of productivity. The use of a single index is believed to be very important because of its motivational value. A single index provides the members of the unit with a sense of productivity improvement or decrement. The single index would also seem beneficial for management information purposes. A large number of pieces of information on organizational functioning can be very difficult to assimilate and use for making decisions. Many approaches to measuring productivity use a single index (e.g. Felix & Riggs, 1983; Joint Financial Management Improvement Program, 1976; Kim, 1980; Peeples, 1978; Tuttle & Weaver, 1986a, 1986b; Tuttle, Wilkinson, & Matthews, 1985).

Conclusions from the Productivity Literature

In summary, there are many approaches, perspectives, and issues relevant to productivity measurement. It is tempting to ask: What is the best definition and perspective to use in conceptualizing productivity? However, we believe that this is the wrong question. Efficiency and effectiveness approaches both have their place, as do the different perspectives. How one resolves some of the other issues such as whether to use a single index of productivity and what to measure depends on the circumstances. The better question is: Under which circumstances is which approach most appropriate?

In order to answer this question, we must determine the purpose of measuring productivity in the Air Force. The purpose will help determine the correct approach. For different purposes, very different approaches would be used.

Our Approach To Organizational Productivity

In the simplest terms, our purpose in measuring productivity is to be able to increase it within a given Air Force organization or part of that organization. It is our assumption that the people in the organization have a great impact on the productivity of the organization. Although the technical subsystem is also important, our focus is not on that part of the system directly but rather on how the technical subsystem is used by the people. Our position is that to increase productivity we need to increase the productivity of the people in the organization through increased motivation. With increased motivation, personnel would exert more effort and be more persistent in their efforts; they would work more efficiently in the sense that their efforts would be more directly related to organizational objectives; and they would improve their work strategies and would use their own and others' time and efforts with less waste.

Although we believe that both efficiency and effectiveness approaches should be included in a productivity measurement system, we believe that the appropriate approach for an Air Force productivity measurement system is to first consider productivity as effectiveness rather than efficiency. We take this position for three reasons. First, effectiveness, with its orientation toward goal attainment, is a broader definition of productivity, since it results in a measurement system that expresses productivity in terms of how good that productivity is. In contrast, an efficiency approach does not carry with it evaluative information on what is a good or bad level of efficiency. The second reason for adopting the effectiveness approach is that this approach can more easily generate a measurement system that combines all aspects of the organization's productivity into a single measure. The final reason is that we believe this approach makes it possible to get an effectiveness measure and weight it by inputs to get a system that combines the best aspects of both the effectiveness and the efficiency approaches.

Given our purpose of increasing productivity in the Air Force, it is critical that the measurement system be complete so that increases in measured aspects of the work are not made at the expense of equally important but unmeasured aspects. Finally, the individual measures should be combined into an overall measure of productivity for both motivational and informational purposes.

Research Questions

Having reviewed the literature and settled upon an appropriate approach, we proceeded toward our specific research objective, which was to provide answers to the following questions:

1. Can the productivity measurement system be effectively developed in an Air Force organization?
2. Will giving feedback with the productivity measurement system increase productivity?
3. Will goal setting and incentives increase productivity over feedback?
4. Will using the system change work attitudes?
5. Will using the system be seen as valuable by the users?
6. Will the system operate successfully after the departure of the research team?

III. METHOD

Site

The present effort was conducted at an Air Force base in the southwestern United States, and involved sections in Maintenance and in Resource Management. The maintenance unit was the Communications and Navigation section (Comm/Nav) in the Component Repair Squadron. There were four sections in Resource Management, which together comprised the Materiel Storage and Distribution Branch (MS&D) of the Supply Squadron. The four sections were Receiving, Storage and Issue, Pickup and Delivery, and Inspection.

The Comm/Nav section repaired a variety of electronic equipment used for aircraft communication and navigation. The number of personnel in Comm/Nav ranged from 29 to 35 during the course of the project. The MS&D branch was essentially the base warehouse. Property was delivered to the warehouse and checked in by the Receiving section. Storage and Issue shelved the property and retrieved it as it was ordered by units on the base. The Delivery section delivered the property to units on base that had ordered it. Inspection made sure the property was in good condition, and ensured that regulations were being followed concerning property packaging, storage, and identification. The number of personnel in the MS&D branch ranged from 47 to 54 during the course of the project, with Receiving averaging 15, Storage and Issue 15, Pickup and Delivery 13, and Inspection 7.

Description of the Productivity Measurement System

The theoretical background for this approach to the measurement of organizational productivity stems from the theory of organizational behavior presented by Naylor, Pritchard, and Ilgen (1980). In this theory, an individual's role is seen as a series of relationships, called *contingencies*. These contingencies not only indicate the important things that the person is expected to do in the job, but also show the relationship between the amount of each of these activities and how that amount is evaluated.

This approach to roles has the advantage of indicating more than the typical information present in role specification. The typical information is limited to a listing of the important duties to be performed on the job. In the Naylor, Pritchard, and Ilgen approach, this information is supplemented by what level of performance is expected in each area, and how positively or negatively each level of performance is evaluated.

In essence, we used the Naylor, Pritchard, and Ilgen conceptual approach of products and contingencies, and extended its application from individuals to organizational units. This application led to the development of a number of unique features for a productivity measurement system. We shall discuss these later in the report.

A second source for the development of our approach was the work of Tuttle (1981; Tuttle et al., 1985; Tuttle & Weaver, 1986a, 1986b). In this work, also supported by the Air Force Human Resources Laboratory, Tuttle developed an approach to measuring productivity which included methods of going from what we call products to obtaining objective indicators of how well these products were provided. He used a variety of group techniques to develop products and indicators, some of which we also used.

Steps in the Development of the Productivity Measurement System.

The technique used to generate the productivity measurement system is described more fully in Pritchard, et al. (1987a), but will be summarized here. It consists of four distinct steps: (a) identify salient products, (b) develop indicators of these products, (c) establish contingencies, and (d) put the system together.

Step 1: Identify Products.

Every organization has a set of activities that it is expected to perform. These activities result in a set of what Naylor, et al (1980) called *products*. In using the term "product," we mean more than merely a tangible thing that is produced. Products can be thought of as the set of objectives that the organization is expected to accomplish. The productivity of the organization is a function of how effectively the organization generates these products. The first step in developing the productivity measurement system is to identify these products.

To present the steps involved in developing the productivity measurement system, we shall use an extended hypothetical example that will make each step more concrete. For this example, we shall use an organization similar to our Comm/Nav section. Assume that the unit diagnoses and repairs electronic equipment. Personnel are responsible for the repair of various items that have malfunctioned and have been brought to the shop for repair. Their primary responsibility is to repair these items as quickly and as accurately as possible. If they repair an item and it does not function properly, it is returned for reaccomplishment of the repair. They are periodically inspected by a Quality Control function, which determines whether they are accurately following the procedures for repair that are detailed in available repair manuals. The maintenance unit also has responsibility for conducting on-the-job training, and a person can repair a piece of equipment only if he/she has passed the training certification required for that piece of equipment. Thus, it is important that a sufficient number of people be qualified through training so that all the items can be repaired in a timely manner.

To develop the system, the first step would be to meet with people from the organization to identify the salient products. Let us assume that the following products are identified:

1. Quality of repair.

2. Ability to meet demand for repairing items (i.e., the organization's ability to repair the needed equipment quickly).

3. Ability to meet training needs (i.e., the degree to which the organization meets its on-the-job training needs).

In actual fact, there might well be more products in such an organization. However, since our intent here is to explain the logic of the system, we shall

use only these three so that the example remains simple enough for clear presentation.

Step 2: Develop Indicators.

Once the products are determined, the next step is to develop *indicators* for each of these products. An indicator is a measure of how well the organization is generating the product in question. The indicators are determined through interaction with the people in the organization, who are asked to think of those things which would show how well people in the organization are producing their products. There may be only one indicator for a given product, or there may be more than one. Some indicators will already be available; some will have to be newly developed. After the indicators are discussed and refined, the products and indicators might look something like this:

Product 1. Quality of repair.

Indicator A: Return rate: percentage of items returned for reaccomplishment of repair.

Indicator B: Percentage of Quality Control inspections passed.

Product 2. Ability to meet demand for repairing items.

Indicator: Number of units repaired divided by total number of units brought in for repair.

Product 3. Ability to meet training needs.

Indicator: Number of people qualified to work on each type of item to be repaired, divided by the number of people needed to be qualified.

As mentioned above, this would not be a complete list of products and indicators for such an organization, but it does serve to explain the concept used for the productivity measurement system.

Step 3. Establish Contingencies.

Once the products and indicators have been identified and approved, the next step is to establish the contingencies. A *contingency* is the relationship between the amount of the indicator and the effectiveness of that amount of the indicator.

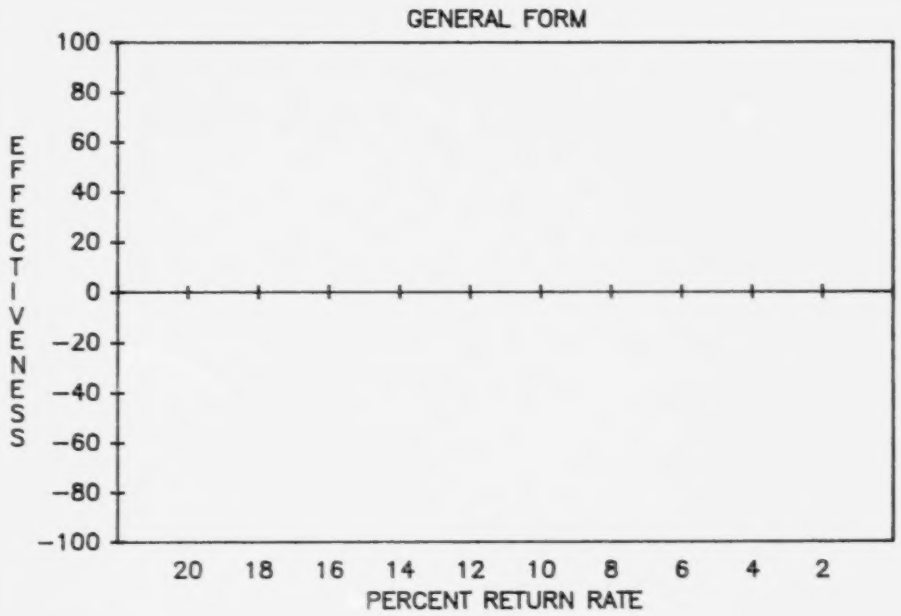
Figure 1 presents an example of a contingency. The top half of the figure shows the general form of a contingency. The horizontal axis represents the amount of the indicator, ranging from the worst possible level to the best possible level. The vertical axis of the figure shows the effectiveness values of the various levels of the indicator. It ranges from +100, which is maximum effectiveness, to -100, minimum effectiveness. It also has a zero point which is defined as the expected or neutral level of effectiveness. That is, the zero point is neither positive nor negative. For this example, we have chosen the first indicator: return rate. Assume that the people in the organization indicate that the best that is ever possible is to have a 2% return rate. They see it as impossible to do better than 2% because approximately 2% of the electronic components they use for repairs can work properly when installed and checked, but fail almost immediately when put into use. Let us assume they say that the worst possible return rate would be 20%.

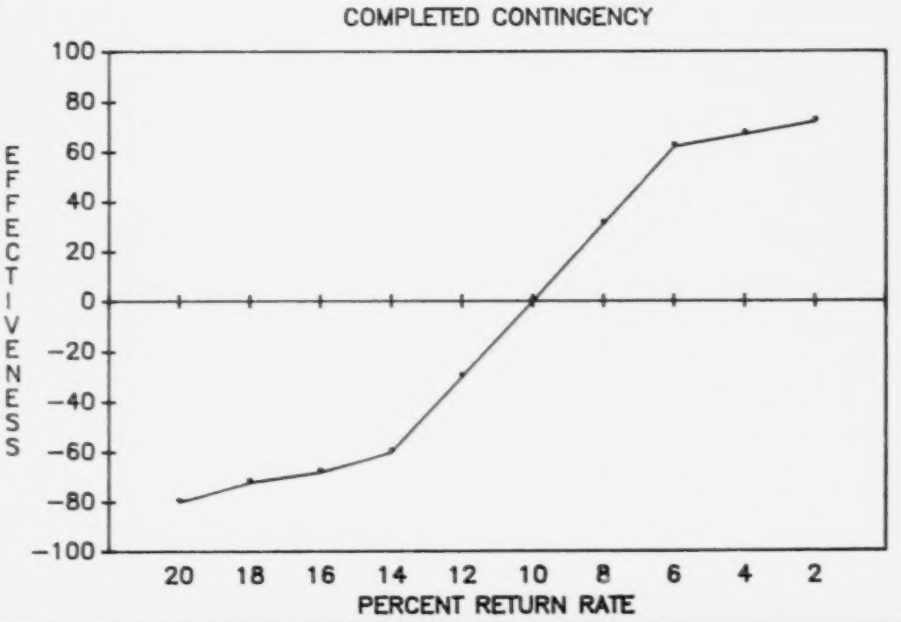
Once the best and worst possible levels of productivity have been established by the organizational personnel, the next task is to determine the zero point; that is, the expected level, the level that is neither especially good nor especially bad in terms of productivity. Once this is established, a point would be placed on the figure at the intersection of the zero point of the vertical axis and the level of neutral point on the horizontal axis. For example, if the neutral point was identified as a return rate of 10%, it would be indicated as shown in the bottom half of Figure 1.

Next, the maximum and minimum effectiveness levels for the indicators would be established. The first step is to list the maximums for each of the indicators. The group of incumbents and supervisors is then asked to rank order these maximums in terms of the contribution of each to the overall effectiveness of the unit. The group discusses this and consensus is reached. The maximum with the highest importance rank is then given an effectiveness value of +100, and the group is asked to rate the other maximums as percentages of the +100 maximum. For example, if the maximum of a given indicator were only half as important to the effectiveness of the unit as the most important (best) maximum, it would be given a value of +50. An analogous process is performed for the minimum values of the indicators, except the most important (worst) minimum is not constrained to a value of -100. It is given the value that the group feels is appropriate.

Once the zero points have been identified and the effectiveness values of the maximums and minimums established, the remainder of the points in the function for each indicator are developed by the group. Group discussion is continued until consensus is reached.

FIGURE 1. EXAMPLE CONTINGENCY





Assume that the personnel in the organization said that return rate was an important aspect of their work, that to be at the minimum would correspond to an effectiveness of -80, and to be at the maximum would be a +70. After the other points on the function are identified, this might result in a contingency such as that shown in the bottom of Figure 1. It indicates that going above the neutral point of a 10% return rate is positive, but changes are not linear, in that once return rate decreases to 6%, further decreases do not represent as great an increase in effectiveness. Likewise, at the low end, once the return rate gets as bad as 14%, they are doing very badly and lower rates are proportionally not as bad.

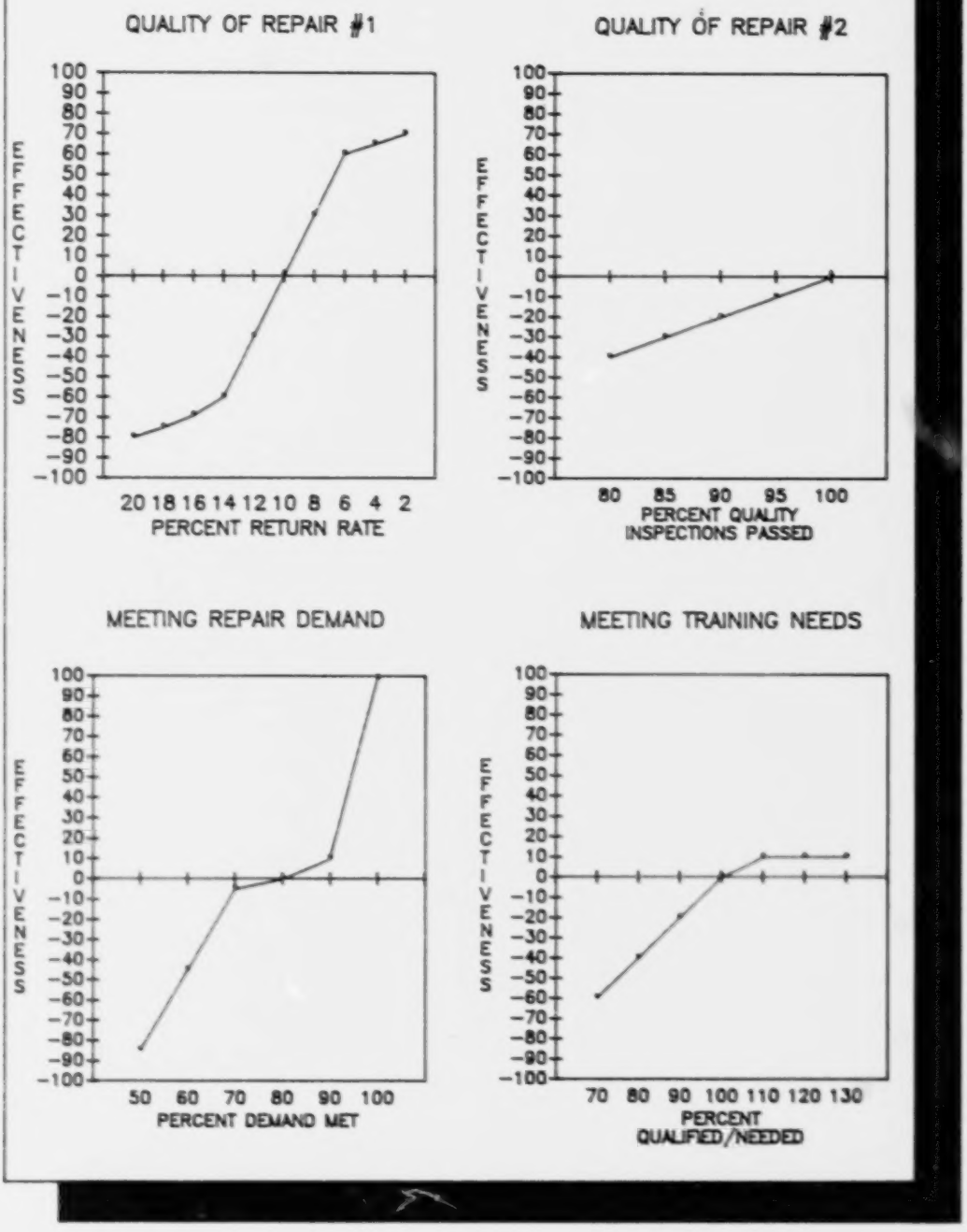
After this process has been completed for each of the indicators, and once all have been scaled and reviewed for accuracy, the contingency set would be complete.

A sample contingency set is presented in Figure 2. For each indicator, there is a contingency with its maximum, minimum, and expected level or zero point, and a function relating it to effectiveness. The first contingency, that for return rate, is the same as that shown in the lower part of Figure 1. The second contingency is for the percent of Quality Control inspections passed. Note that for this contingency the expected level is that 100% of these inspections be passed. Recall that these inspections are not inspections of the final work but rather, inspections of the process the technician goes through in doing the repair. It is an index of how well the person is following the manual in doing the repairs. It is expected that all repairs will be done in accordance with the manual. Thus, this contingency shows that the expected level is doing all repairs (100%) in accordance with the manual. Since it is not possible to pass more than 100% of inspections, there are no positive values. Thus, anything less than this is below expectations, and results in negative effectiveness. Together, these two contingencies cover the product of quality of repair.

The second product has only one indicator, and hence only one contingency. The product is ability to meet repair demand, and the indicator is the number of units repaired divided by the number brought in, expressed as a percentage. This contingency is roughly linear, except that a value within the 90% to 100% range represents a major jump in effectiveness.

The last product is meeting training needs, and also has only one indicator - number of people qualified (through training) to repair equipment, divided by the number needed, expressed as a percentage. For this indicator it is possible to go above 100% since, although the organization needs only 15 people to be qualified to

FIGURE 2. EXAMPLE CONTINGENCY SET



repair a given piece of equipment, it could actually have more than 15. However, the contingency becomes flat after 110%, indicating that having more than 110% is no more effective than having 110%. The idea is that once there is a small excess over the maximum number needed, having additional trained personnel is not important.

Two things are particularly noteworthy about these contingencies. The first is that the overall slope of the function expresses the relative importance of the indicator. For example, the overall slope for the first indicator (return rate) is steeper than for the second indicator (percent of inspections passed). This reflects the fact that although it is important to pass inspections which show that the process of doing the repair was accurate, actually doing the repair so that the item functions properly is more important. Second, the contingencies can be non-linear. As shall be discussed below, this is necessary to accurately reflect the realities of an organization's functioning. In many cases, the relationships that actually exist are simply not linear.

It is important to recognize what these properties of the contingencies do. First, the contingencies reflect differential importance. Different things the organization does are not equally important. Aspects of the work that are very important get steeper contingencies than aspects that are less important. For example, in Figure 2, the first indicator for quality of repair has a range in effectiveness from -80 to +70, whereas meeting training needs ranges from -60 to +10. This indicates that quality of repair is more important than meeting training needs since variations in quality of repair have a greater impact on the effectiveness of the organization. Thus, the relative importance of each aspect of the work is incorporated into the contingencies.

Secondly, contingencies allow for the existence of non-linearities between amount of the measure and productivity. A linear relationship would mean that to improve a given amount at the low end of the measure would be as good as improving that same amount at the high end. However, in the real world it is very common for values in the middle range of an indicator to represent large improvements in productivity, and values at the high end to represent a point of diminishing returns. That is, once an organization gets to a fairly high level of productivity on one aspect of the work, it is frequently better to try to improve something that they are not doing as well, rather than continue to improve something that is already at a high level.

For example, if the repair shop were operating with a very low return rate, it might be better to try to improve meeting training needs rather than attempting to further improve its return rate. Thus, even though return rate

overall is more important than training, if return rate is good, improving a low degree of training readiness can become more important to the overall effectiveness of the organization. Another example of this non-linearity would be a situation such as that depicted for training needs. Once the organization reaches a certain point, further increases are not more effective since all the people that are necessary are already trained. The contingencies in our system capture this non-linearity and thus provide a more accurate picture of the organization's functioning.

Step 4. Put the System Together.

Once the contingencies are completed and approved by management, the last step is to put the system together. This would be accomplished by first collecting the indicator data for a given period of time. If the time period selected were a month-long period, the data for the four indicators would be collected at the end of the month. Then, based on the contingencies, effectiveness scores would be determined for each indicator by calculating the effectiveness for that level of the indicator. This is illustrated in Figure 3. For example, if the maintenance unit had a return rate of 6% in the month of March, examining the contingency indicates that such a return rate is associated with an effectiveness score of +60 (i.e., a value of 6% return rate on the horizontal axis is associated with an effectiveness value of +60 on the vertical axis). Continuing this process would give an effectiveness value for each indicator, as exemplified in the Figure 3.

Once the effectiveness values are determined, they can be summed to obtain the overall effectiveness score for products with more than one indicator, as seen for the first product. The total effectiveness of the product Quality of Repair would be the sum of the two indicators comprising that product: +60 for return rate and -10 for quality control inspections passed, for a total of +50. Next, overall productivity can be calculated by summing all of the effectiveness scores. In the example, this Overall Effectiveness score is +20.

These effectiveness scores have a distinct meaning, in that a score of zero means that the organization is meeting expectations; that is, their productivity is neither particularly good nor bad. As the score becomes positive, they are exceeding expectations. The more positive the score, the more they are exceeding expectations. As the score becomes negative, they are below expectations. The closer they are to the maximum possible overall effectiveness score, the closer they are to their best possible productivity.

Figure 3. Completed System.

PRODUCTIVITY: MAINTENANCE UNIT

DATE: March, 1987

	INDICATOR DATA: MARCH	EFFECTIVENESS SCORE
I. Quality of Repair		
A. Return Rate	6%	+60
B. Percent Quality Control Inspections Passed	95%	-10
Total Effectiveness: Quality of Repair = +50		
II. Meeting Repair Demand		
A. Percent Demand Met	90%	+10
III. Meeting Training Needs		
A. Percent Qualified/Need	80%	-40
OVERALL EFFECTIVENESS =		**+20**

This ability to simply sum effectiveness scores is one of the major advantages of the system. Because the contingencies reflect the relative importance and the non-linearity of the indicators, these factors are already incorporated in the system; thus, a simple summing does indeed reflect the overall effectiveness of the unit. As will be discussed later, this property also makes it possible for the system to be used to aggregate across individual units to determine the productivity of larger and larger units of the organization.

Quality of the System

In order for this approach to be a good measure of organizational productivity, it is obvious that it needs to be accurate. This means several things. It means that the listing of products and indicators must be complete. The system can easily produce a situation where those things that are measured are attended to, and those that are not measured are somewhat ignored. If there are important functions of the unit that are not included in the products, or if important indicators are omitted, this uneven attention to important functions can have very dysfunctional consequences for the organization. In addition to being complete, the system must accurately reflect what the unit should be doing. This means that the products, indicators, and contingencies that are used in the system must be the correct objectives, must be accurate measures, and must be correctly scaled on effectiveness.

Both accuracy and completeness are dealt with in the development of the system by having a clear process of approval of the system at higher levels of the organization. This approval process is made clear from the start. That is, at the beginning of the development of the system, all participants are told that incumbents and supervisors will develop the products and indicators, which will then be presented to higher management for approval. Once higher management has approved the products and indicators, the supervisory groups develop the contingencies, which must also be formally approved by higher management. Although this approval mechanism, and the multiple inputs that it provides, does not guarantee completeness and accuracy of the system, it provides a system of checks and balances so that the system will be as complete and accurate as possible.

A final point about the quality of the system is that the development of the system necessarily introduces subjectivity into the system. Subjectivity is present in the listing of the products and indicators, and especially in the ratings that are used in the contingencies. Subjectivity is present, but this is not necessarily a problem. The elements of the system--products, indicators, and contingencies--are actually statements of policy. As a whole, they say (a) what is important to

the functioning of the unit, (b) the level of output that is expected (the zero point), (c) how good other levels of output are, and (d) the relative importance of different types of functions for the unit. These determinations represent policy, and policy is a subjective thing. A manager's primary responsibility is to set policy, in the sense that he/she must determine the priorities for resource allocation within his/her unit. What this approach does is to reduce ambiguity in policy and priorities by formally discussing them, quantifying them, and subjecting them to formal review and approval by the management of the organization.

Priorities

There are two other unique features of the productivity measurement system that should be described; the first is the system's capability to generate unit priorities.

The system offers a way to develop a clear set of priorities for improving productivity. Recall from Figure 3 that for a given time period (e.g., a month), the system presents the actual amount of each indicator achieved for that period, and the effectiveness levels of those amounts of the indicators. It would be a simple matter to look at the contingency for each indicator and calculate the effectiveness gain that would occur if the unit went up one increment on each of the indicators during the next period. For example, if the unit had a return rate of 6% in March, as is indicated in Figure 3, for them to go to the next level up (a 4% return rate) in April would mean an increase in effectiveness from +60 to +65, for a gain in effectiveness of +5 units. This could be calculated for each indicator. Once it was calculated, one could rank order the changes from highest to lowest gain. Such a listing for our example is shown in Figure 4.

This information communicates exactly what should be changed to maximize productivity. The example shows that the best thing the unit can do is to focus their efforts on meeting repair demand if they want the highest increase in productivity. Once this is done, or if it is not possible at the present time, the next best thing they could do is to improve training so that more people are qualified. Improving quality control inspections and improving return rate are the least important in terms of increasing productivity, with quality control inspections slightly more important.

Thus, the system can generate a set of priorities that unit personnel can use to guide their efforts to increase productivity. This would aid in decisions about resource allocation, and where to focus to identify barriers to productivity.

Figure 4. Priorities for Increasing Productivity.

PRIORITIES FOR: APRIL, 1987

CHANGE	GAIN IN EFFECTIVENESS
Percent Demand Met from 90% to 100%	+90
Percent Qualified (Training) from 80% to 90%	+20
Percent Quality Control Inspections Passed from 95% to 100%	+10
Return Rate from 6% to 4%	+5

Aggregation Across Units

A second unique feature of the productivity measurement system is the ability to aggregate across organizational units. It is quite valuable to have a productivity measurement system for a given unit, or several units. It would be even more valuable if one could aggregate the measurement system from the several different units into one measure applicable across all the units. For example, if a branch were composed of four separate units, it would be valuable to have a measure for each unit, and to be able to combine those four measures into a single measure for the entire branch. In most productivity measurement systems this is not possible, since the measurement system varies from unit to unit. An advantage of our approach is that it is possible to do such across-unit aggregation. Each unit is measured on a common metric: overall effectiveness. The method for combining their individual effectiveness values to determine the overall effectiveness across units merely involves a simple additional scaling step in the development of the contingencies; this procedure is explained in detail in the report on the productivity measurement system (Pritchard, et al., 1987a).

This rescaling process has the effect of adjusting the effectiveness scores of the different units in the branch for any differences in importance of the different units. Once it is finished, the overall effectiveness values from the different units can simply be summed to determine the overall effectiveness of the entire branch. This approach to aggregation can be extended to larger and larger units, so that, if desired, a single index of the productivity of the entire organization can be developed.

System Development

To actually develop the productivity measurement system at the base, meetings were held jointly with incumbents and supervisors. First products and then indicators were developed. Once the products and indicators had been finalized by group consensus, the next step was to obtain approval of the products and indicators from higher management. Meetings were held with higher management where the products and indicators were presented, discussed in detail, and, with some revisions, approved. As an example, the final set of products and indicators for Comm/Nav are presented in Figure 5.

The next step was the development of the contingencies. Meetings were again held with incumbents and supervisors of each unit. First, the maximum and minimum indicator levels were established; then the zero points were generated. These decisions also took considerable time, resulted in considerable initial disagreement, and were done over multiple meetings. These meetings were

Figure 5. Comm/Nav Products and Indicators.

Product 1. Equipment Repair

Bounces: Percentage of repaired equipment that did not function immediately after installation.

Percent QA (Quality Assurance) inspections passed.

AWM: Number of units awaiting maintenance.

AWP: Number of units awaiting parts.

Demand Met: Percentage of equipment brought in for repairs that was actually repaired.

Product 2. Training

STS Tasks Completed: Mean number of standard (more basic) training tasks completed for personnel in training.

Percent Qual Tasks Completed, Comm: Mean percent of advanced training tasks completed for personnel repairing communications equipment.

Percent Qual Tasks Completed, Nav: Mean percent of advanced training tasks completed for personnel repairing navigation equipment.

Scheduled Training Tasks Overdue: Total number non-technical (e.g. military) training requirements not met on time for all shop personnel.

Product 3. Other Duties

Mobility Equipment: Number of pieces of equipment used for mobility exercises that were not calibrated by the shop on schedule.

PMEL Overdue: Number of pieces of shop calibration and test equipment that were not calibrated by the shop on schedule.

Percent 349 Errors: Percent of errors on a major manpower documentation form.

Missed Appointments: Number of formal on-base appointments missed.

held until consensus was established. The contingencies were then presented to management for discussion and approval.

Treatments

Once the productivity measurement system was completed, the next phases of the research involved instituting the interventions of feedback, goal setting, and incentives. To do this, a baseline was first established. This amounted to a period of eight months for MS&D and nine months for Comm/Nav where indicator data were collected, but no feedback was given to the units. These data provided a baseline against which the effects of the interventions could be evaluated.

The schedule was as follows: First, each of the five units developed its productivity measurement system. This was followed by the baseline period. Next, feedback was given to each unit for five months. Goal setting was then added to feedback for each unit, and continued for another five months. Finally, incentives were added to feedback and goal setting in each unit for five months.

Feedback

Productivity feedback consisted of formal computer-generated reports that were given to the personnel in each section monthly. To develop these reports, we first produced examples of what the basic report would look like and asked for supervisors' thoughts on how best to present the material for maximum clarity. We also proposed some other information that they might find useful, and asked for their suggestions on items to be included. After several revisions, a final version of the productivity feedback report was developed. An example of the monthly report for the Comm/Nav shop is presented in Figure 6.

The first page of the report provides the basic productivity data. It shows the products and indicators, the indicator data for that month, and the effectiveness score associated with that level of each indicator. The lower portion of the page shows the total effectiveness for each of the products and finally, the overall effectiveness for the shop. The second page of the report adds information to the basic data. The top half of the report shows the change in productivity from the previous month to the current month. The indicator data and effectiveness scores for both the previous month and the current month are shown, as are the changes in effectiveness from last month to the current month. This part of the report was requested by shop personnel to aid them in diagnosing areas where they were increasing or decreasing in productivity.

Figure 6. Sample Feedback Report.

PRODUCTIVITY REPORT
COMM/NAV SHOP
CRS MAINTENANCE

INDICATOR AND EFFECTIVENESS DATA FOR MARCH

INDICATOR	INDICATOR DATA	EFFECTIVENESS SCORE
EQUIPMENT REPAIR		
BOUNCES	3.1	76
% QA INSPECTIONS PASSED	90.9	30
AWM	13.5	80
AWP	39.6	29
DEMAND MET	91.7	63
TRAINING		
STS TASKS COMPLETED	8	35
% QUAL TASKS COMPLETED: COM	69.5	72
% QUAL TASKS COMPLETED: NAV	56.8	68
SCHED TRAINING TASKS OVERDUE	0	10
OTHER DUTIES		
MOBILITY EQUIPMENT OVERDUE	0	25
PMEL OVERDUE	0	25
% 349 ERRORS	1	40
MISSED APPOINTMENTS	0	10

TOTALS	EFFECTIVENESS SCORE
EQUIPMENT REPAIR	278
TRAINING	185
OTHER DUTIES	100
OVERALL EFFECTIVENESS	563

Figure 6. (Concluded)

EFFECTIVENESS CHANGE FROM FEBRUARY TO MARCH

	INDICATOR DATA: FEBRUARY	EFF. SCORE	INDICATOR DATA: MARCH	EFF. SCORE	CHANGE IN EFF.
BOUNCES	2.8	81	3.1	76	-5
% QA INSPECTIONS	91.7	34	90.9	30	-4
AWM	15.58	72	13.5	80	8
AWP	40.6	27	39.6	29	2
DEMAND MET	91.5	59	91.7	63	4
STS TASKS COMPLETED	9	52	8	35	-17
%QUAL TASKS-COMM	68.6	72	69.5	72	0
%QUAL TASKS-NAV	59.5	71	56.8	68	-3
SCHEDULED TRAINING TASKS OVERDUE	0	10	0	10	0
MOBILITY EQUIPMENT OVERDUE	0	25	0	25	0
PMEL OVERDUE	0	25	0	25	0
% 349 ERRORS	2	27	1	40	13
MISSED APPOINTMENTS	0	10	0	10	0

CHANGE TOTALS	
EQUIPMENT REPAIR	5
TRAINING	-20
OTHER DUTIES	13
OVERALL EFFECTIVENESS	-2

POTENTIAL EFFECTIVENESS GAINS FOR NEXT MONTH

	FROM	TO	GAIN
BOUNCES	3.1	0.4	17
QA INSPECTIONS	90.9	100	45
AWM	13.5	0	15
AWP	39.6	22.6	48
DEMAND MET	91.7	95.2	37
STS TASKS COMPLETED	8	9	17
%QUAL TASKS COMP: COMM	69.5	76	0
%QUAL TASKS COMP: NAV	56.8	62.8	4
SCHED TRNING TSKS OVERDUE	0	0	0
MOBILITY EQ OVERDUE	0	0	0
PMEL OVERDUE	0	0	0
349 ERRORS	1	0	15
MISSED APPOINTMENTS	0	0	0

The bottom half of the page is the information on priorities for increasing productivity. For each indicator there is a column labeled FROM, TO, and GAIN. The FROM column is the amount of the indicator done for the current month. The TO column is the amount of the indicator that represents an increase of one unit on the contingency, and the GAIN column indicates the gain in effectiveness that would be achieved by such an increase. For example, for repair demand met, if the shop went from their March level of 91.7% to 95.2% in April, effectiveness would increase by 37 points. Examination of the GAIN column indicates that for the next month, the shop would increase their productivity the most by focusing on Quality Assurance Inspections, and the number of units Awaiting Parts (AWP). These show potential gains in effectiveness of 45 and 48 respectively. It would not be useful to devote attention to training in Comm Qualification Tasks, trying to further decrease Overdue Scheduled Training Tasks, or any of the other indicators that have a gain value of zero or near zero. This information can therefore serve as a basis for determining priorities for the next month. It suggests those areas where the unit should focus to produce maximum gains in effectiveness. The feedback report for MS&D was similar to this Comm/Nav report. A copy of this report is included in Pritchard, et al. (1987a).

The calculation of the GAIN amount is based on the amount of increase in effectiveness that would occur with an increase of "one unit" of the indicator. The size of a one unit increase was determined from the indicator values used in the contingencies. If the indicator values in a contingency were 2%, 4%, 6%, 8%, etc. the size of a one unit increase for that indicator was 2%. If the indicator values were 50, 60, 70, 80, etc., the size of a one unit increase was 10. The contingencies were originally developed so that the number of increments for the different contingencies was as equal as possible so that a "one unit" increment was roughly comparable across the different contingencies. Once the size of the "one unit" increase was determined for each contingency, the TO figure was calculated by adding the one unit increase to the actual value of the indicator for the preceding month. If the last month's indicator level was 83.6 and the size of one unit was 10, the FROM value would be 83.6, the TO value would be 93.6, and the GAIN value would be determined by what the contingency indicated as the gain in effectiveness if the unit went from 83.6 to 93.6 on that indicator.

There was one special circumstance that had to be dealt with using this approach. It was possible for the TO value to be higher than the maximum value of the indicator. This occurred when the unit was already high on that indicator and increasing "one unit" would put them over the maximum. It also occurred occasionally if the unit was already over the maximum on that indicator. This was dealt with by using the maximum possible effectiveness value for the

indicator as the upper limit in effectiveness. In other words, if the effectiveness value for being at the maximum of the indicator was +75, this was the maximum effectiveness score that could be gained from that indicator. If the unit was near the maximum already with, for example, a past month's indicator level which yielded an effectiveness score of +73, the most they could improve would be to the value of the ceiling, +75, for a maximum gain of only +2.

One feature of the system is that it allows one to directly compare the productivity of very different units. This feature was very important to the supervisors and managers of the MS&D branch since it allowed them to compare the four sections of the branch. In order to make this comparison, we first determined the maximum possible overall effectiveness for each section. This was done by determining the effectiveness value for the maximum possible value of each indicator, and summing these effectiveness values. The resultant score represented the effectiveness value that would occur if the unit was doing as well as it was possible to do on every aspect of their work; in other words, their maximum possible overall effectiveness. Recall that these maximums were developed by consensus among the supervisors of the units, and were discussed and approved by management. Thus, they should represent realistic maximums, and the effectiveness scores represent the value of the maximum contribution each of the units could make to the organization.

Once the maximum possible effectiveness was calculated, the actual monthly overall effectiveness score for each section was expressed as a percentage of maximum possible effectiveness. This percentage of maximum effectiveness was the measure by which each unit was compared to the other. These data were included in the monthly feedback report for each section of MS&D.

The feedback report was generated each month for 15 months for each of the five units. It was presented within three workdays after the end of the month, and a copy was given to each individual in the chain of command, from the section supervisors to the Deputy Commander. A copy was also posted in the working area of each section so incumbents could review it. In addition, graphs were posted in the work area and updated each month: one for overall effectiveness, and one for each indicator. These graphs allowed unit personnel to see changes in effectiveness over time. As one might imagine, both the feedback report and the graphs generated considerable interest when they were posted each month.

Once the feedback reports were circulated, a meeting was held with incumbents, supervisors and, for MS&D, a management representative to review the feedback report for the month. Areas of improvement were noted and areas of

decrease discussed. Reasons for the improvements or decreases were considered, and any longer-range trends were noted. This meeting also served as a basis for planning priorities for the next month, and for altering work strategies to improve productivity.

Goal Setting

After five months of feedback, goal setting was added to the receiving of feedback reports. The first step in implementing goal setting was to train the personnel in setting productivity goals. The nature and process of goal setting was explained to them, and the importance of their participation was stressed. They were told the importance of setting a difficult but attainable goal. Prior to the start of the goal setting program, a meeting was held with supervisors and incumbents to explain how the program would work. They were told to discuss goals among themselves for a few days. After this time, the first goal setting sessions were held. These were attended by members of the research team to facilitate the process, and especially to ensure participation and to encourage them to set reasonable goals.

One issue that became quite significant was whether the goals would be "reportable" or "non-reportable." Unit personnel were reluctant to set goals that represented difficult but attainable goals, if the goals were to be reported to higher management. They feared that they might be held to whatever goals they set and would thus receive a negative evaluation if these goals were not met, even if productivity had actually increased. It was decided that public or reportable goals would be set at a level that would be low enough to ensure that the unit would exceed them. Such goals would have little motivational force, and fail to have a positive effect on productivity. Thus, the goal setting system was designed to be non-reportable; that is, the goals would be for section use only, and would not be communicated to higher management. Section incumbents and supervisors set the goals, members of the unit knew what the goals were, but the goals were not communicated beyond branch supervisors. Upper management agreed to the use of non-reportable goals. They felt that if productivity continued to be as high as it had been during feedback, or if it improved, they did not need to know the unit goals that helped produce such results.

Comm/Nav and each of the four units of MS&D set goals for themselves in terms of their overall effectiveness for the following month. Goals were set jointly by incumbents and supervisors. When the month-end feedback report was produced, the unit personnel noted whether or not they had attained the goal, and discussed reasons why the goal was or was not met. The goal was then reviewed and reset for the following month.

Incentives

After five months of feedback plus goal setting, incentives were added as the final treatment. Following considerable discussion and input from samples of incumbents up to senior management, the incentive chosen was time-off from work. Specifically, unit personnel were given a half day or full day off if the unit achieved the level of productivity needed to qualify for the incentive. This incentive seemed powerful for the personnel involved and was feasible to implement.

Several other issues had to be dealt with in designing the incentive system. One was the number of levels of productivity that would be defined as resulting in different incentive levels. At one extreme is a system where there is a single level of productivity that, if reached, leads to an incentive. At the other extreme is a piece-rate-type system where each increase in productivity leads to an increase in the amount of incentive. The advantages of the single-level approach are that it is simple to administer and can be used with any type of incentive. The advantage of the multiple-level approach is that no matter where the unit's productivity is, there is still an incentive to increase productivity further. With the single-level approach, once the level of productivity that produces the incentive is reached, there is no incentive to increase productivity further.

Another design issue concerned the effects of asking the units for higher and higher levels of productivity. At the time the incentive system was being designed, all the units had greatly increased their productivity. In one sense, the system had asked them to increase their productivity during feedback and again during goal setting. If the incentive system asked for even greater improvement before any incentives were awarded, we felt there was a possibility of a negative reaction to the program.

There was also an issue of setting the incentive levels so that they were equitable across units. For Comm/Nav this was not a problem since they had little contact with MS&D. However, the four sections of MS&D were in constant contact with one another, and the system had to be designed such that no one section had an easier time obtaining time-off than another. If the participants judged the system to be inequitable, it could not be effective.

Finally, there was the issue of whether to use branch-level incentives in addition to the section-level incentives in MS&D. The four units of MS&D had to cooperate extensively to get the work done. It would have been possible for a given section to do things that maximized their overall effectiveness but which

caused problems for the other sections. Therefore, the incentive system had to have a mechanism for fostering cooperation among the units.

The incentive system was designed with these issues in mind. The system used two levels of the incentive, a half day off and a full day off.

Comm/Nav received a half day off if their overall effectiveness exceeded the mean overall effectiveness for the five immediately preceding months. If they exceeded this level by a meaningful amount (as determined jointly by incumbents, supervision, and management), they received a full day off. It was decided that for the full day off to be awarded, overall effectiveness must exceed the mean of the last five months by 5%. Since Comm/Nav was very close to their maximum possible effectiveness by this time, a 5% increase was judged to be a substantial improvement. One problem with this system was that if productivity continued to increase, the mean of the last five months would continue to rise. This would mean that it would be more and more difficult for the unit to achieve the productivity level necessary for incentives. Eventually, continued increases in productivity would make it impossible to get any incentives. To deal with this problem, a maximum was set on the overall effectiveness level necessary to get the incentives. For the half day off, the maximum level was set at 85% of their highest possible overall effectiveness; for the full day off, the maximum was set at 94%.

MS&D also had two levels of the incentive, but with a different structure. A given section received a half day off if its overall effectiveness exceeded the mean overall effectiveness of the five highest productivity months prior to the start of incentives. In practice, this meant that they would receive the incentive if their productivity exceeded the mean productivity under goal setting. There was also a branch-level incentive of an additional half day off to be given to each section if the branch reached its incentive level on overall effectiveness. This productivity level for the branch to get the additional half day off was essentially the sum of the section-level goals. That is, the individual section incentives were given when the section's productivity continued at a very high level. To get the branch incentive, productivity had to be maintained at this high level for *each* section. This was done since it was felt that several of the sections were already performing very near the maximum possible level, and asking them to go above this to get the full day off as in Comm/Nav was unreasonable. If a section reached its incentive level and the branch reached its level, that section received a full day off. If the section reached its level but the branch did not, the section received a half day off. If the section did not meet its incentive level but the branch did, the section received a half day off.

Thus, the system dealt with the issue of asking for higher and higher productivity in Comm/Nav by having one level of the incentive for continuing to maintain previous high levels of productivity, and a second level of incentive for exceeding that productivity. For MS&D, this issue was dealt with by requiring that a section maintain its high level of productivity for the half day off, and that all sections maintain high productivity for the full day off. A branch-level incentive was used in MS&D in addition to the section-level incentive. This incentive was structured in such a way that sections were encouraged to cooperate. To get the greater incentive, the entire branch had to do well. A section could have a bad month and still get a half day off if they could help the rest of the sections pull up the branch total. Another possibility was that a section that was doing extremely well would help another section so that both would get time off.

The issue of equity across sections in MS&D was dealt with by first explaining the issue of equity to the personnel, and then having incumbents, supervisors, and management of the different sections jointly determine what levels of productivity should be reached to obtain incentives in each of the sections.

During the incentive treatment, the units continued to set their own performance goals and review them each month. We felt that perhaps after the incentive treatment started they might simply set their goals equal to the level needed to receive time-off, and thus, continuing goal setting might be unnecessary. However, the goal setting was continued so that the individual units could set different goals if they so desired, and so that the integrity of the experimental design was maintained. Specifically, by allowing units to continue their own goal setting, we could assess the incremental effects of incentives when added to goal setting. If goal setting had been discontinued, assessment of this incremental effect would not have been possible.

IV. RESULTS

The results of the effort will be presented in five sections: (a) development of the productivity measurement system; (b) effects on productivity; (c) results for the feedback, goal setting, and incentive interventions; (d) attitude data; and (e) effects after the departure of the research team.

Development of the Productivity Measurement System

There were a number of results--both qualitative and quantitative--pertinent to the development of the productivity measurement system.

One qualitative result was the change in the attitudes of the unit personnel during the development of the system. When we first started working with them, their attitudes toward the project were mixed. Although some unit personnel were positive, others were more skeptical. Those with the more negative attitudes felt that the researchers were non-military outsiders who did not know the details of their work situation but were going to impose a management system about which these personnel had reservations. Though these people were willing to cooperate, they definitely had their doubts. Through the course of the system development, their attitudes changed dramatically. By the time system development was completed, most unit personnel had positive attitudes toward the effort. They were solidly behind the system, felt positive toward the researchers, and were quite disappointed that they had to wait through the necessary months of baseline before feedback could begin.

A second qualitative finding deals with interpreting the strength of the productivity results. Development of the system, by its very nature, led the participants to examine unit objectives, suggest possible measures of these objectives, and evaluate their productivity expectations and limits. This process led unit supervisors to see numerous places where improvements could be made in the operation of the units. They began to implement these changes. This created a real dilemma for the researchers. Although it was certainly worthwhile for the units to improve their effectiveness because of the development of the system, this improvement was occurring prior to the start of our baseline. If, because of this, the baseline period showed higher effectiveness than it otherwise would have, there would be a decrease in the size of any feedback effect. There was little the researchers could do about this dilemma. The units felt strongly that such changes should be made, and made them. They felt these changes were increasing their effectiveness, and this indeed seemed to be the case, based on what little data were available at the time. Interviews with supervisors indicated that they believed a substantial portion of this improvement was due to the process of developing the productivity measurement system. This suggests that the improvements in productivity that were evidenced in the interventions were, in fact, underestimates of the overall impact of the development and introduction of feedback from the productivity measurement system.

The reliability and validity of the system were also assessed during development of the system. Reliability was assessed by examining interjudge agreement on the contingencies. The Comm/Nav shop had two shifts in operation. Personnel from both shifts were involved with the development of products and indicators. To assess reliability, we developed two independent sets of contingencies; this produced two effectiveness scores for each value of each indicator: one set from the day shift and one set from the night shift.

Correlations calculated between the two sets of values for each contingency ranged from a low of .86 to a high of .99, with an average of .95. Thus, the reliability of the contingencies as measured by interjudge agreement was quite high.

The validity of the system was evaluated using five different productivity scenarios of hypothetical indicator data developed for Comm/Nav. This was done by selecting a reasonable value for each indicator in such a way that the different scenarios varied as to their overall effectiveness. Although the overall effectiveness of each of the five scenarios varied, the differences were not so large as to be completely obvious. Also, the changes in indicator values varied, but not always in the same direction. That is, although the overall effectiveness went up in a given scenario, some indicator values went down, while others went up. Six Comm/Nav supervisors were then given the indicator data on the five scenarios and asked to rank the scenarios as to their overall effectiveness. If the system accurately reflects relative importance, having supervisors rate the scenarios without knowing the scenario overall effectiveness scores should produce ratings which are highly correlated with overall effectiveness as calculated by the system.

These ratings were done approximately two months after the development of the system had been completed, but before any productivity feedback had started. Results showed a correlation of 1.0 between each supervisor's rankings and the overall effectiveness score calculated by the system. This constitutes additional evidence for the validity of the system.

Finally, data were also collected on subjective reactions to the productivity measurement and feedback system. All incumbents and supervisors (N = 97, which includes some supervisors not technically part of the units, but in their chain of command) were surveyed after several months of experience with the feedback system. The survey asked for their reactions to different aspects of the feedback system. The survey items consisted of 5-point Likert scales with response formats ranging from Strongly Agree to Strongly Disagree. Responses to these items were uniformly positive. Table 1 presents the items and the percentage of respondents who agreed or strongly agreed and the percentage who disagreed or strongly disagreed. After reverse-scoring the negatively phrased item (#12), the mean percentage of respondents across all items who Strongly Agreed or Agreed was 64.7%, while the corresponding percentage who Disagreed

Table 1. Subjective Evaluation of the System

ITEM	PERCENT AGREE OR STRONGLY AGREE	PERCENT DISAGREE OR STRONGLY DISAGREE
1. The feedback system tells me how good a job I am doing.	64	4
2. The feedback system tells me how good a job the section is doing.	87	1
3. The feedback system helps me see the section's priorities.	77	6
4. The feedback system helps the section be more productive.	61	4
5. A system like this would help other Air Force bases be more productive.	62	4
6. The feedback system is clear and understandable.	58	7
7. It was worth the effort to develop the feedback system.	64	10
8. It was worth the effort to keep the feedback system in operation.	62	10
9. The information about section performance that goes into the feedback system is accurate.	52	13
10. The feedback system gives a good measure of productivity.	64	13
11. Overall, I like the feedback system.	62	9
12. I would prefer not to have this feedback system at the next organization I work in.	13	54
13. The feedback system is a better way of measuring productivity than what the section used to have.	75	0
MEANS =	64.7	7.2

or Strongly Disagreed was 7.2%. Clearly, the response to the system by those who used it was very positive.

Effects On Productivity

Once the system was developed and a baseline was established, the system was used to generate feedback. Next, goal setting was added to feedback, and finally incentives were added.

The overall effects across the five units are shown in Figure 7, which plots the mean of the overall effectiveness of the five sections over time. As the figure indicates, overall effectiveness increased substantially over the baseline.

In order to calculate a single index of change in productivity, we calculated the percent gain from the baseline compared to maximum possible gain. That is, mean overall effectiveness was calculated from the baseline. The difference between this value and the maximum possible overall effectiveness the section could obtain was calculated. This maximum possible effectiveness was determined by calculating the overall effectiveness score if the unit produced at the maximum possible value for each of the indicators. The gain in overall effectiveness from baseline to each treatment was then calculated, and expressed as the percentage of maximum possible gain. For example, assume that the baseline mean was 400 and the maximum possible overall effectiveness was 800. If the mean overall effectiveness during feedback was 600, this would be a gain of 200. This is 50% of the maximum possible gain, and would be the value reported. This approach to calculating change is in some ways conservative, in the sense that the maximum possible increase is limited to 100%.

Using this approach, the average increase over baseline was 50% for feedback, 75% for goal setting, and 76% for incentives. Figure 8 presents similar data for Comm/Nav alone. The data show average increases of 30% for feedback, 65% for goal setting, and 68% for incentives. Figure 9 presents the data for MS&D alone. Average percent increases were 54%, 77%, and 79%. Finally, Figures 10, 11, 12, and 13 show the productivity effects for each of the four sections of MS&D.

These results indicate a major increase in productivity. The effects were extremely large. In addition, the MS&D effects were consistent across sections.

FIG. 7 PRODUCTIVITY OF ALL FIVE SECTIONS COMBINED

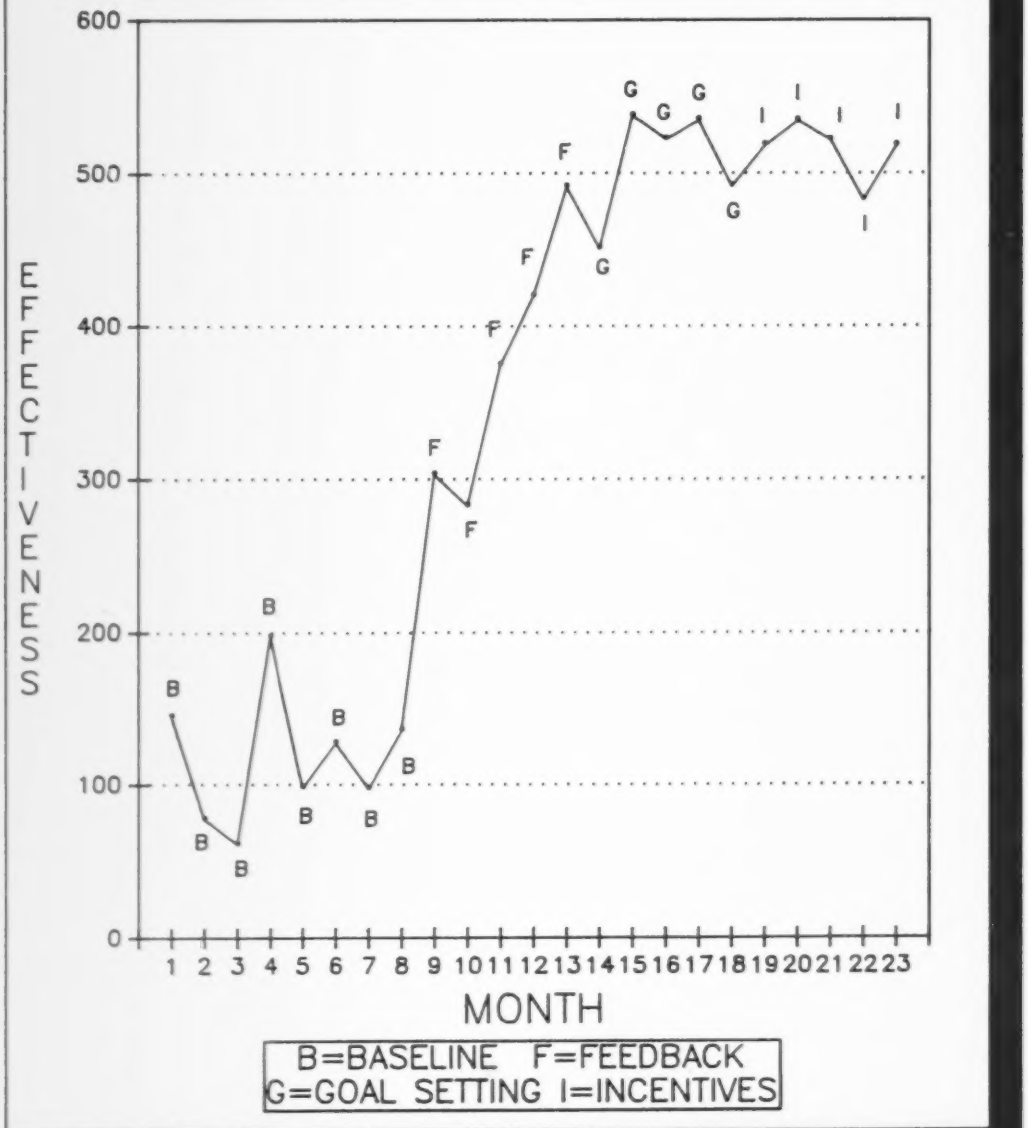
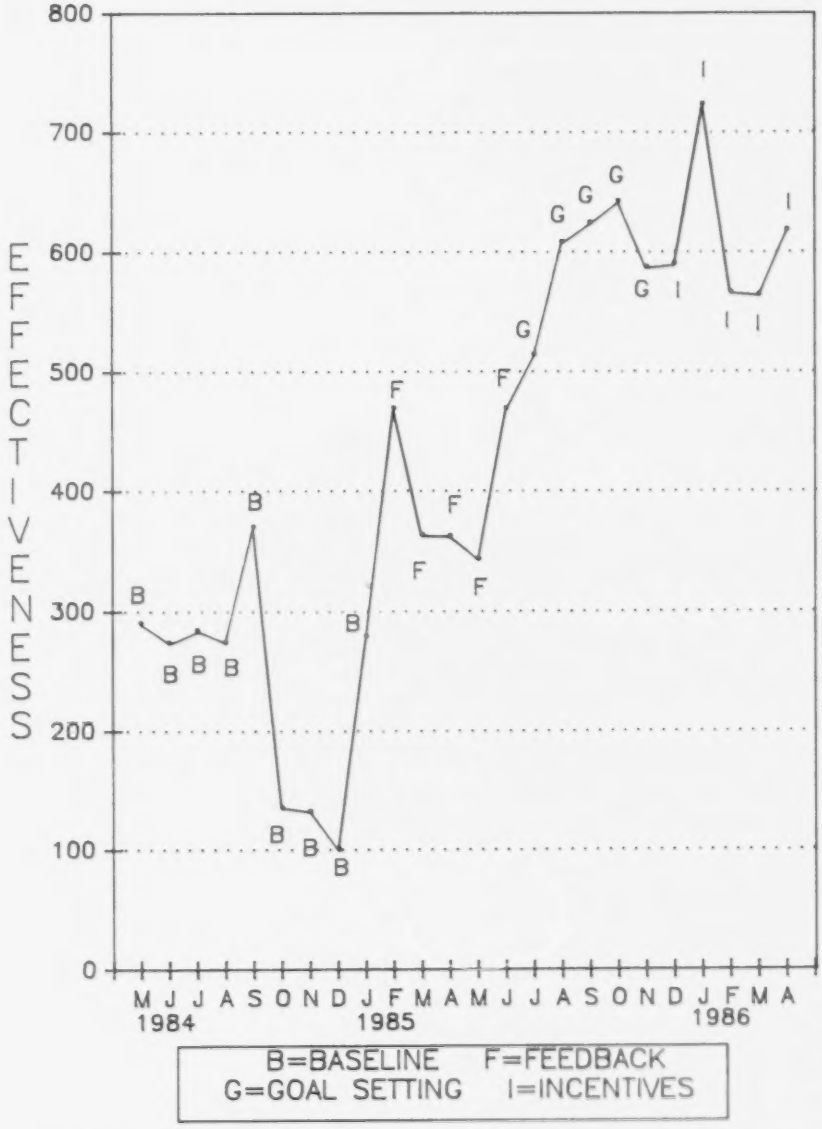
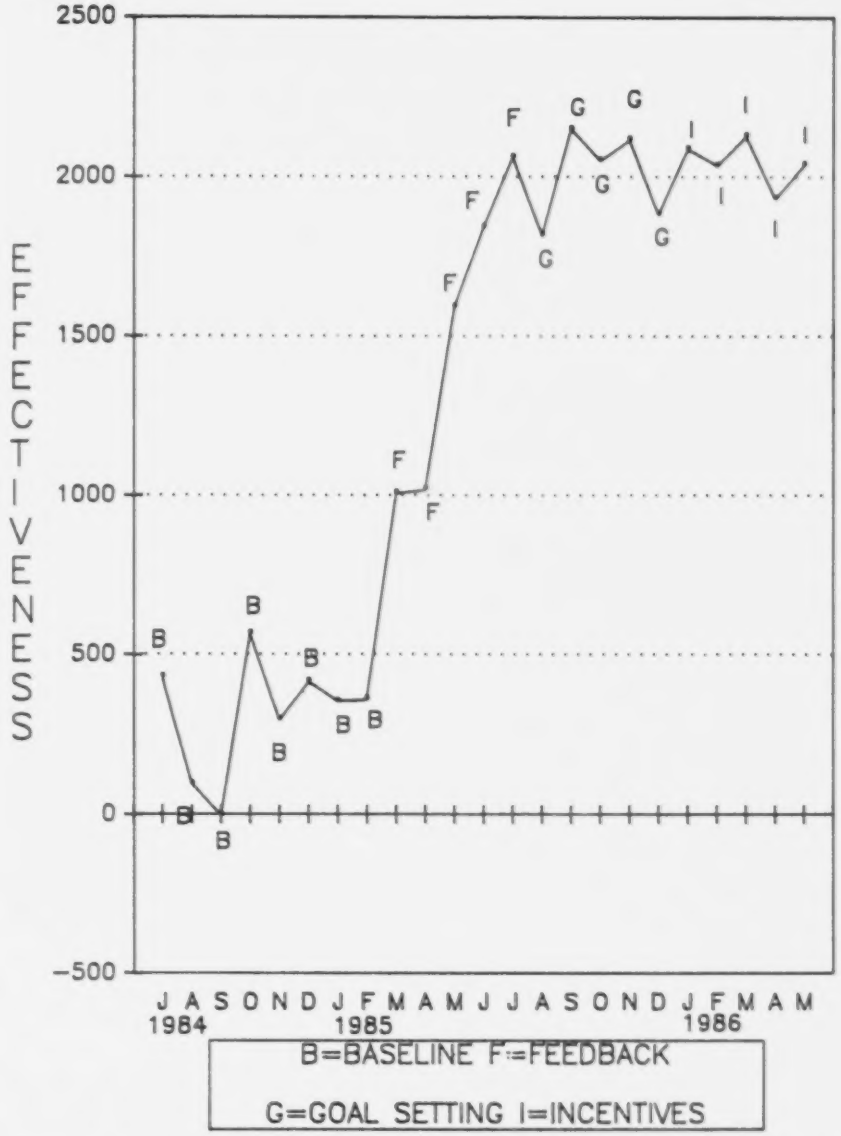


FIG.8 COMM/NAV PRODUCTIVITY



TOTAL SECTION EFFECTIVENESS OVER TIME

FIG.9 MS&D PRODUCTIVITY



TOTAL BRANCH EFFECTIVENESS OVER TIME

FIG. 10 RECEIVING OVERALL EFFECTIVENESS

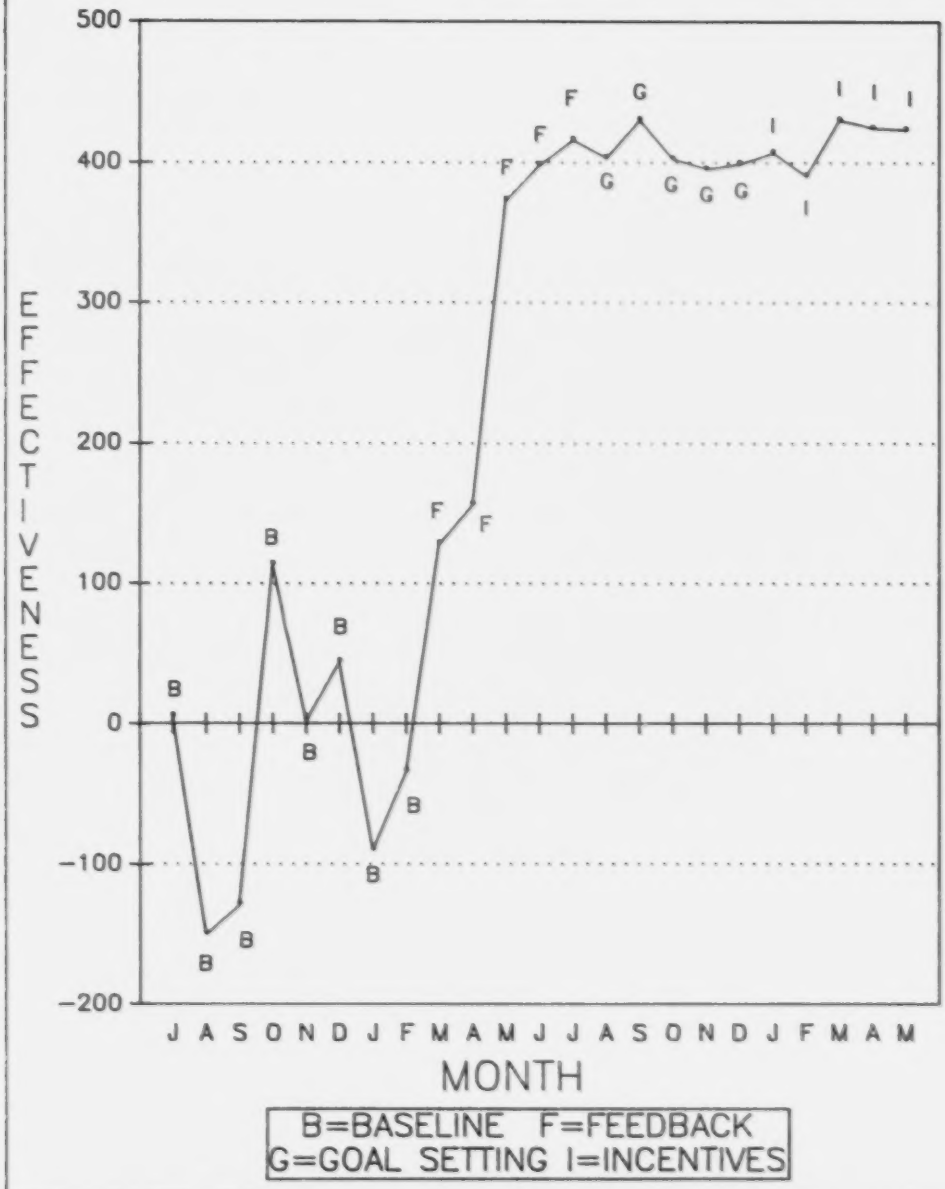


FIG. 11 STORAGE & ISSUE OVERALL EFFECTIVENESS

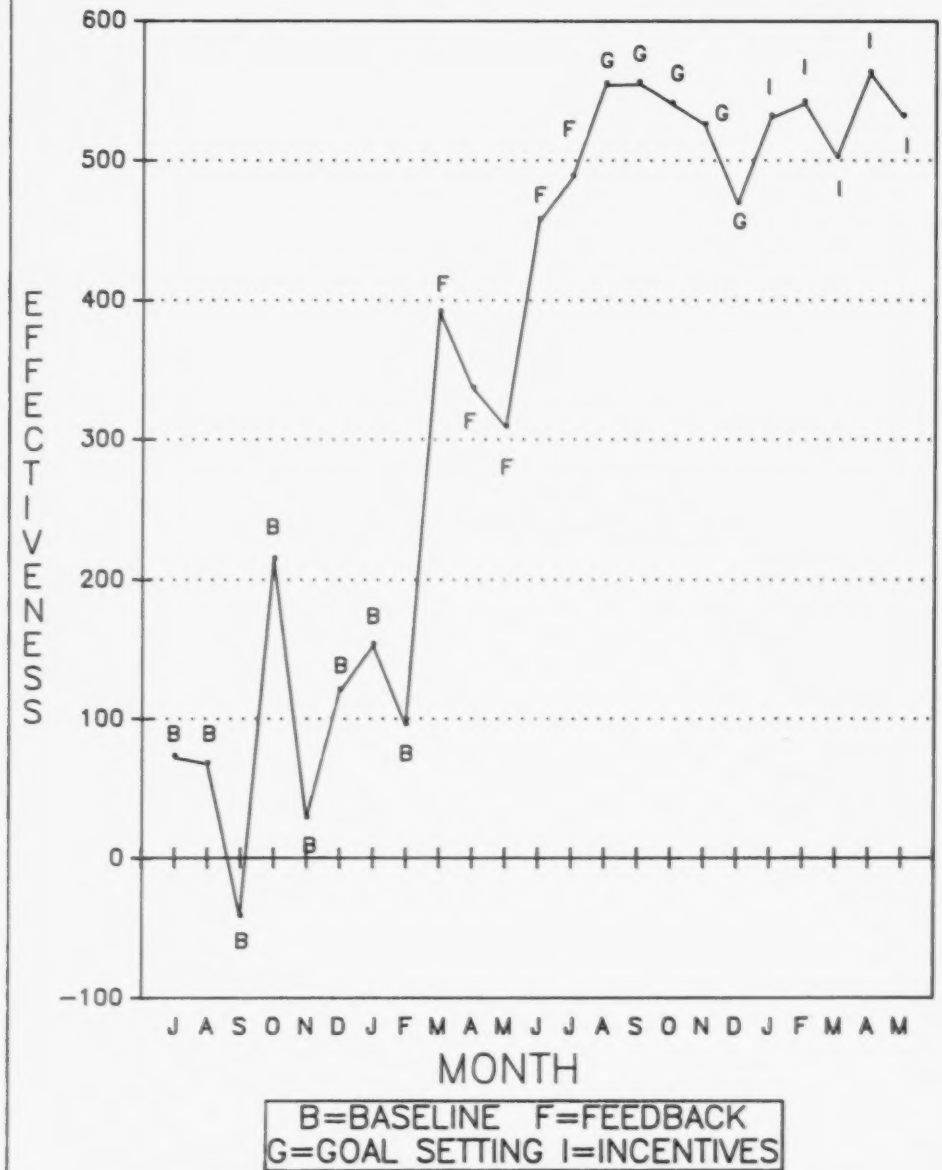
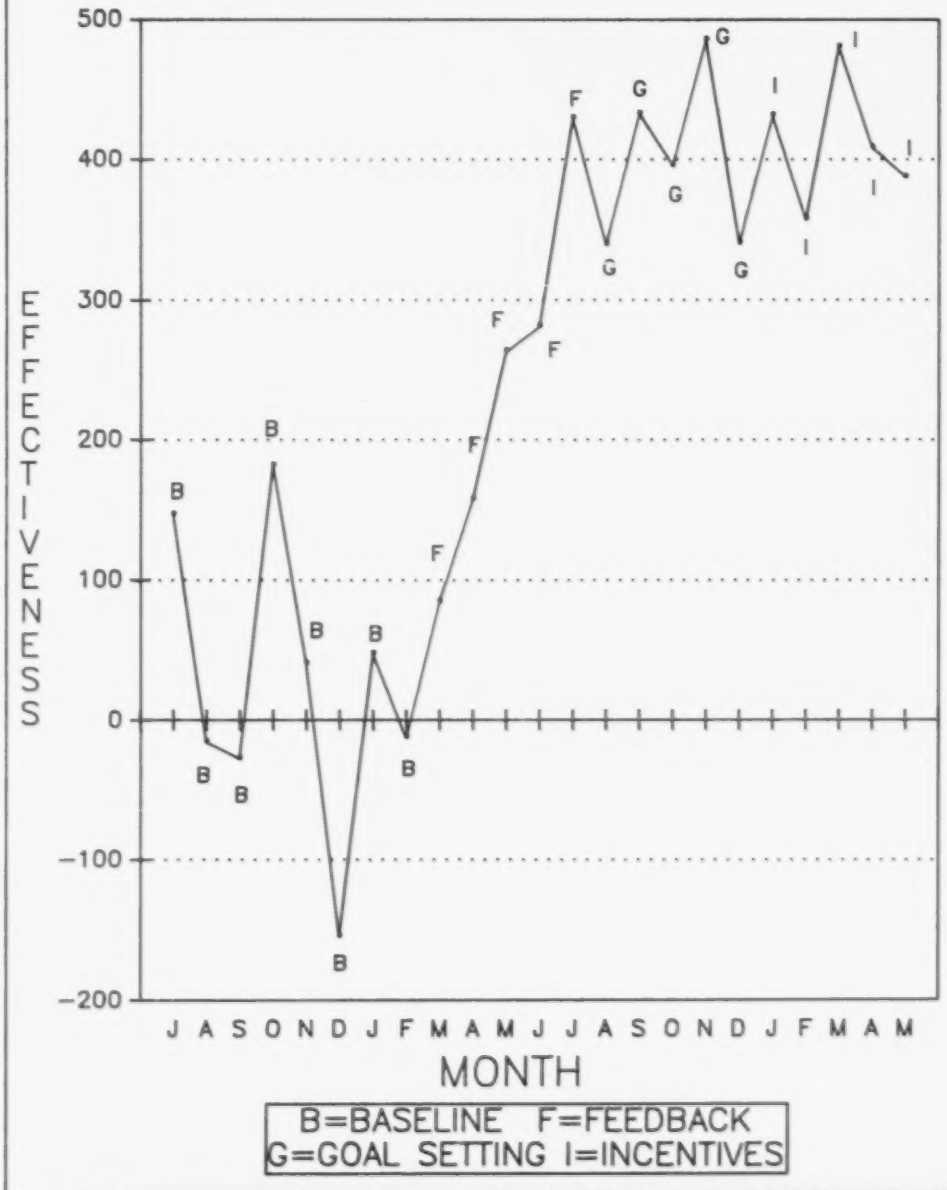
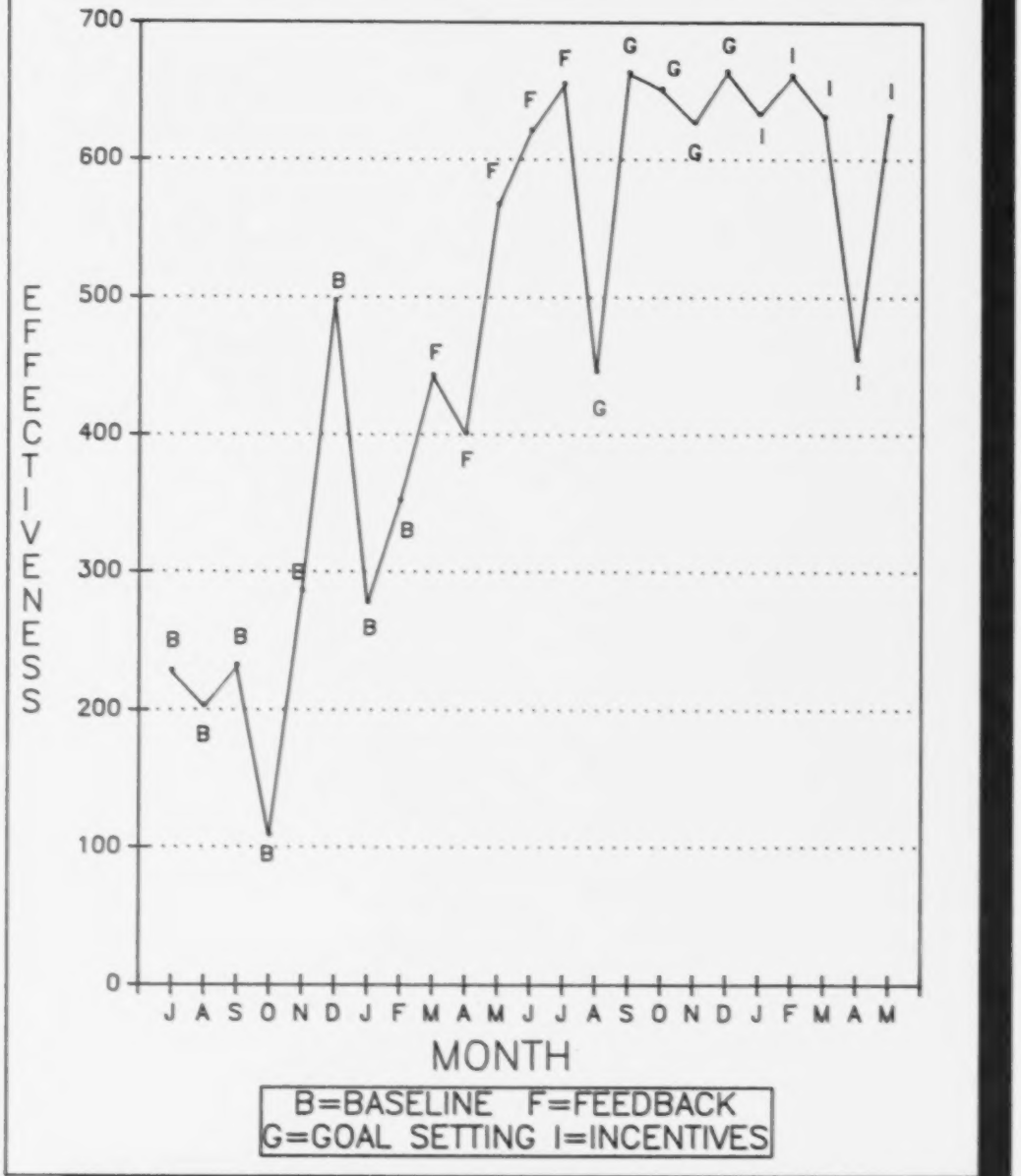


FIG. 12 PICKUP & DELIVERY OVERALL EFFECTIVENESS



63

FIG. 13 INSPECTION OVERALL EFFECTIVENESS



Potential Problems of Interpretation

Before we can confidently attribute these effects to the experimental interventions, several issues must be considered. The first is the possible presence of a Hawthorne effect, where productivity could have increased simply because the units were singled out for the special treatment of being in a research project. Although such an effect is indeed possible, the project was designed to avoid possible contamination from such an effect. Specifically, the initial contact with the units during system development was quite intensive, and if a Hawthorne effect was going to occur, it should have occurred then. Since this was well before the start of the baseline, any productivity increase would have already occurred and would not contaminate the results. Thus, the presence of a Hawthorne effect cannot explain the productivity increases.

Another possibility was that the increases in productivity which occurred during the treatments might have been due to increases in the number of personnel in the units. For Comm/Nav, we looked at the total number of personnel in the shop during each month of the effort. The mean number of personnel by month is presented in Figure 14. The mean number of personnel during baseline was 30.9. This figure increased slightly during feedback to 33.0, was 32.8 during goal setting, and dropped to 31.0 during incentives. Since personnel levels during the period of highest gain in productivity were essentially equal to the level during baseline, we concluded that the increases in productivity were not caused by an increase in number of personnel. For MS&D, the data reviewed were total number of personnel, and the number of hours of overtime logged per month. Unlike Comm/Nav, MS&D routinely had considerable overtime. The number of personnel for MS&D by month is also presented in Figure 14. The mean was 51.8 for baseline, 53.7 for feedback, 48.4 for goal setting, and 49.2 for incentives. Thus, the overall number of personnel decreased over the period of the treatments. The overtime data presented in Figure 15 show that number of hours of overtime decreased during the time that productivity increased. Overtime went from a mean of 1,348 hours per month during baseline to 892 during feedback, 404 during goal setting, and 416 during incentives. Thus, by the end of the treatments, overtime was less than one-third of what it was during baseline. These data indicate that by the end of project, the productivity gains that had occurred were made with no increase in number of personnel in Comm/Nav, and a decrease in manpower in MS&D.

Finally, it was possible that there could have been changes occurring in the larger organizations, of which the five experimental units were part, which caused general increases in productivity for all units. To explore this possibility productivity data were collected on several sections that were similar to the

FIG. 14 PERSONNEL FOR COMM/NAV AND MS&D BY MONTH

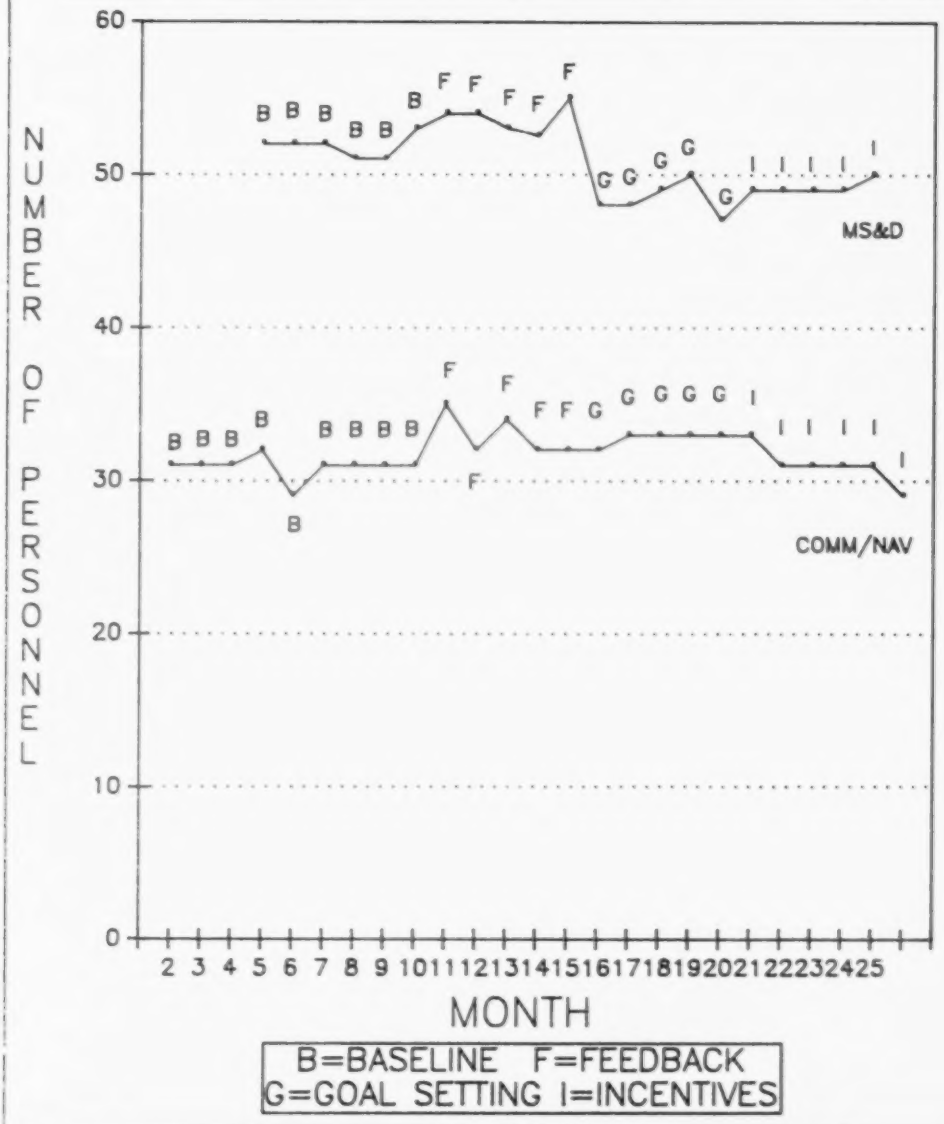
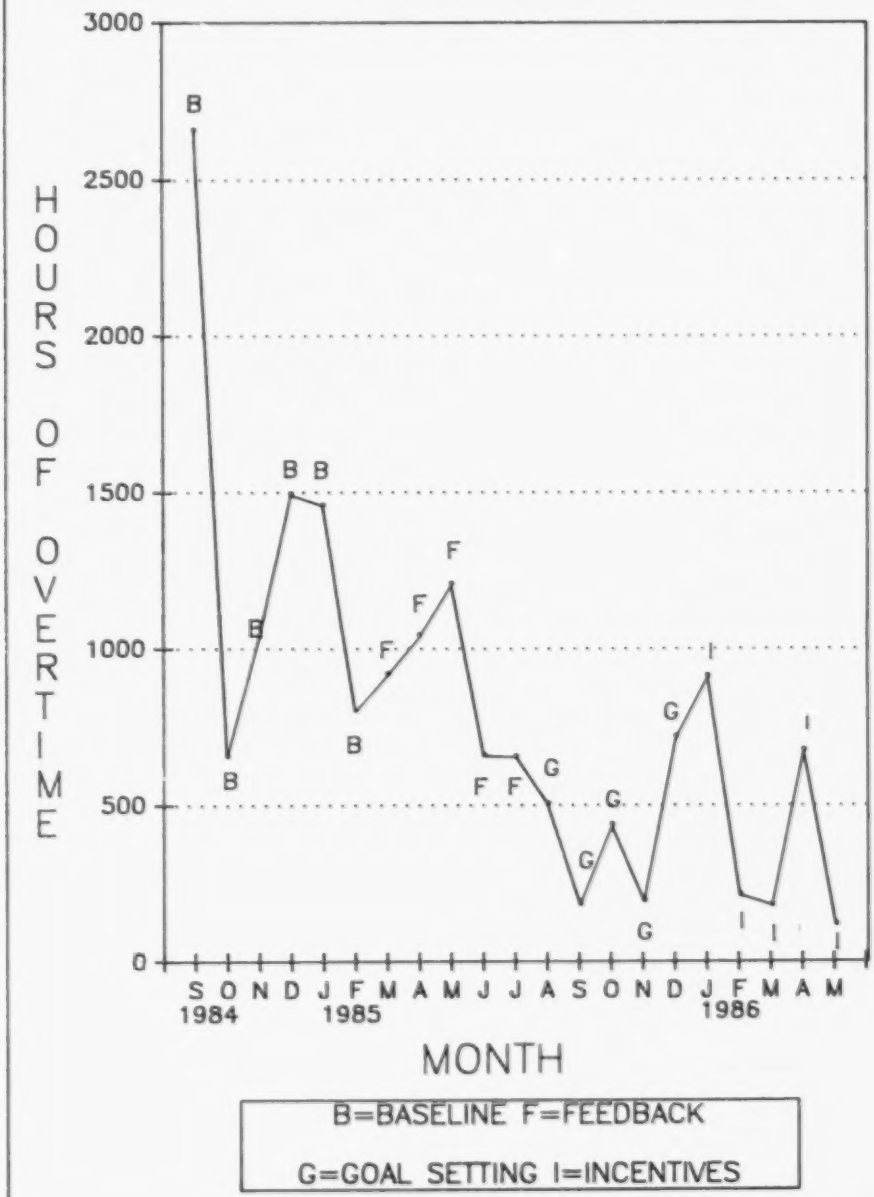


FIG.15 MONTHLY HOURS OVERTIME—MS&D



experimental groups in the type of work they did. The idea was to compare changes in the productivity of these sections with changes in the five experimental units. If the productivity of these control units increased as much as that of the experimental units, then the experimental units' increased productivity was most likely not attributable to the interventions.

Control group data for Comm/Nav consisted of ten measures of productivity from eight maintenance units in the Component Repair Squadron, of which Comm/Nav was one section. The data were collected from baseline and put into a composite measure to express overall productivity of the control groups. This composite measure was the sum of the ten measures. A plot of this composite is presented in Figure 16. In Figure 16, the letter B, F, G, or I is used to indicate which months of control group data correspond to the treatments. The control groups did not receive these interventions.

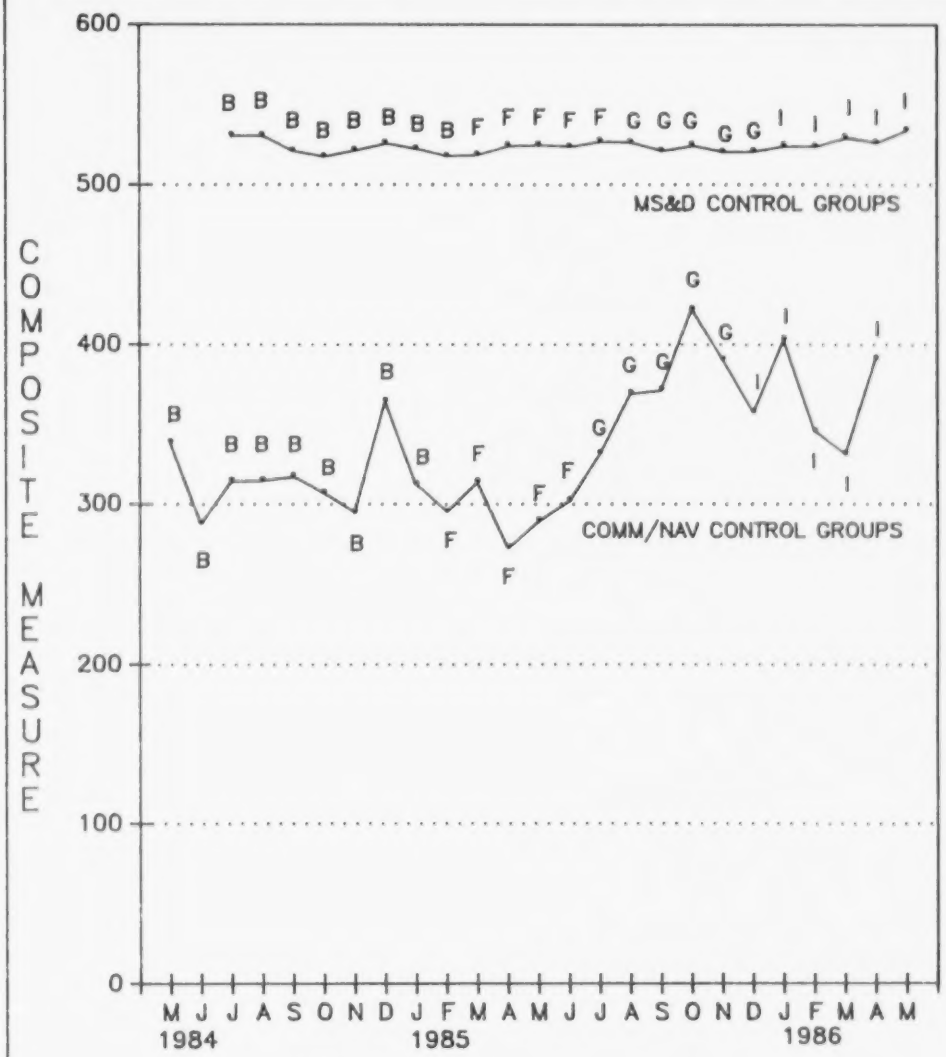
The mean value across the ten Comm/Nav control group measures during baseline was 317. It dropped to 295 during feedback, and rose to 377 and 365 during goal setting and incentives, respectively. These results show that the control groups decreased somewhat in productivity during the Comm/Nav feedback period, and increased thereafter. We believe, therefore, that the productivity increase during feedback in Comm/Nav was not due to wider organizational changes, since the productivity of other squadron units actually decreased during this period. Furthermore, the increases during the Comm/Nav goal setting and incentives periods were not present across all units. These increases were brought about primarily by large increases in productivity on two of the ten control measures.

Productivity data on four control measures were examined for MS&D. These measures reflected overall functioning of the Supply Squadron (exclusive of MS&D) and one other unit outside of Supply. None of these units was part of the interventions. The composite index is also presented in Figure 16. The mean of these four measures during baseline was 516; it was 512 for feedback, 511 for goal setting, and 518 for incentives. Thus, there were essentially no changes in productivity for the MS&D control groups.

In summary, the control group data indicate that the effects on productivity that occurred in the experimental units cannot be explained due to wider organizational changes in productivity.

Having examined the possibility of Hawthorne effects, effects due to increases in the number of personnel, and effects caused by wider organizational changes, we believe it is safe to conclude that the changes in productivity that

FIG. 16 CONTROL GROUP DATA



TREATMENT IN MS&D OR COMM/NAV
DURING MONTH: B=BASELINE F=FEEDBACK
G=GOAL SETTING I=INCENTIVES

occurred were attributable to the experimental interventions. In addition, our subjective impressions and the reactions of the personnel in the units completely convinced us that this was the case.

Indicator Data

We have shown the positive effects on overall effectiveness. Let us now examine the effects on the indicators themselves. Tables 2 and 3 present the mean values for each indicator, by treatment, for Comm/Nav and MS&D, respectively. For example, Table 2 shows that, on the average, there were 5.9% bounces (i.e., 5.9% of the items repaired were returned for reaccomplishment of repair) during the baseline period. During the incentives period, the average decreased to 2.5%.

In addition, the data for the most important indicators for each of the five units are plotted by month in Figures 17 through 22. These were the indicators judged most important by unit personnel, supervisors, and managers. For Comm/Nav the two most important indicators were percent of repair demand met and percent of bounces. For MS&D, the most important indicators for the Receiving, Storage and Issue, and Pickup and Delivery sections were the speed with which they handled "priority 2" material. Priority 2 items were the most important items they dealt with, usually a part for an aircraft that could not perform its mission without that part. The most important indicator for Inspection was the number of aircraft parts that had not been inspected by the end of the day. The fewer the number of parts, the more effective the unit.

These results indicate that the effects of the system were very powerful. Inspection of the table indicates that major productivity increases occurred. The graphs show how dramatic some of the changes were.

Feedback, Goal Setting, and Incentive Results

We have presented results on the effects of feedback, goal setting, and incentives; however, it is instructive to focus on them more directly. Direct comparisons of the three treatments are presented in Figures 23 and 24. Figure 23 is a plot of mean overall effectiveness by treatment. This figure presents two sets of results: overall effectiveness summed across all five sections (Comm/Nav and MS&D), and overall effectiveness across the four MS&D sections alone. Figure 24 presents similar results separately for each of the five sections (Comm/Nav and MS&D).

Table 2. Comm/Nav Indicator Means by Treatment

INDICATOR	Baseline	Feedback	Goals	Incentives
% Bounces - [1]	5.9	4.5	2.7	2.5
% QA Inspections Passed +	91.9	88.7	90.0	92.6
# Units Awaiting Maintenance -	23.3	18.8	11.8	10.4
# Units Awaiting Parts -	44.6	39.0	32.8	36.9
% Demand Met +	88.5	90.5	93.9	92.6
# STS Tasks Completed +	5.1	6.4	6.8	8.6
% Qual. Tasks, Comm +	57.9	58.9	68.1	69.4
% Qual. Tasks, Nav +	40.0	42.5	55.0	60.1
# Scheduled Trn. Overdue -	1.3	0.0	0.0	0.0
# Mobility Eq. Overdue -	.4	0.0	0.0	0.0
# PMEL Overdue -	.9	0.0	0.0	0.0
# 349 Errors -	8.8	1.2	1.3	1.7
# Missed Appointments -	.2	1.0	.2	0.0

1. A - after an indicator signifies that a smaller mean is higher productivity, a + after an indicator signifies that a larger mean is higher productivity.

Table 3. MS&D Indicator Means by Treatment

INDICATOR	Baseline	Feedback	Goals	Incentives
Receiving				
In-checking Errors/100 - [1]	22	13	0	0
Priority 2 Rec (Min) -	118.6	20.5	16.2	16.3
Priority 4 Rec (Hrs) -	23.4	5.3	6.5	4.3
# Whse Refusals in Receiving -	2.8	1.8	0.0	0.0
# Delinquent Rejects -	137.6	27.2	1.9	1.2
Storage and Issue				
# Inspection Findings -	15.3	19.0	12.2	9.4
# Whse Refusals Wrong Location -	2.5	.8	0.0	.2
% Cleared Off R36 +	89.1	96.5	98.9	98.3
Priority 2 Iss (Min) -	60.8	13.4	9.5	8.9
Priority 3 Iss (Min) -	117.7	22.3	15.8	20.9
Priority 4 Iss (Hrs) -	4.8	10.5	2.8	2.7
# Repeat Findings -	0.0	0.2	0.2	0.0
Pickup and Delivery				
# Delinquent Turn-ins -	44.0	23.8	0.0	0.1
Priority 2 Iss (Min) -	64.0	35.3	27.4	27.1
Priority 2 Rec (Min) -	98.3	42.0	33.1	34.2
Priority 3 (Min) -	76.5	52.0	35.9	35.9
Priority 4 (Hrs) -	32.5	20.3	19.7	16.6
Vehicle Inspection Score +	93.6	94.6	94.4	95.5
# Reportable Accidents -	0.0	0.0	0.0	0.0
# Non-reportable Accidents -	.3	.4	.2	.0

1. A - after an indicator signifies that a smaller mean is higher productivity, a + after an indicator signifies that a larger mean is higher productivity.

Table 3. (Concluded)

MS&D Indicator Means by Treatment

INDICATOR	Baseline	Feedback	Goals	Incentives
Inspection				
# Incoming Items Left -	12.9	5.4	4.5	6.0
# Dated Items Left -	.3	.4	.1	0.0
# Unidentified Items Left -	17.6	9.5	2.2	5.0
# Aircraft Parts Left -	2.2	.7	.3	0.0
# Functional Checks Left -	.6	.1	.1	.4
# Suspect Items Left -	.5	0.0	.1	0.0
# Late Monthly Inspections -	4.3	.4	0.0	.2
# Returns From DP -	1.0	0.0	0.0	0.0
% TCTOs Checked +	100.0	99.8	100.0	100.0
# RODS From Other Bases -	6.5	6.8	5.6	7.4
# Off Base Shipments Left -	1.8	.2	.3	.1
Branch Level Indicator				
# Delinquent Documents -	306.6	139.2	60.0	48.2

FIG.17 COMM/NAV PERCENT DEMAND MET

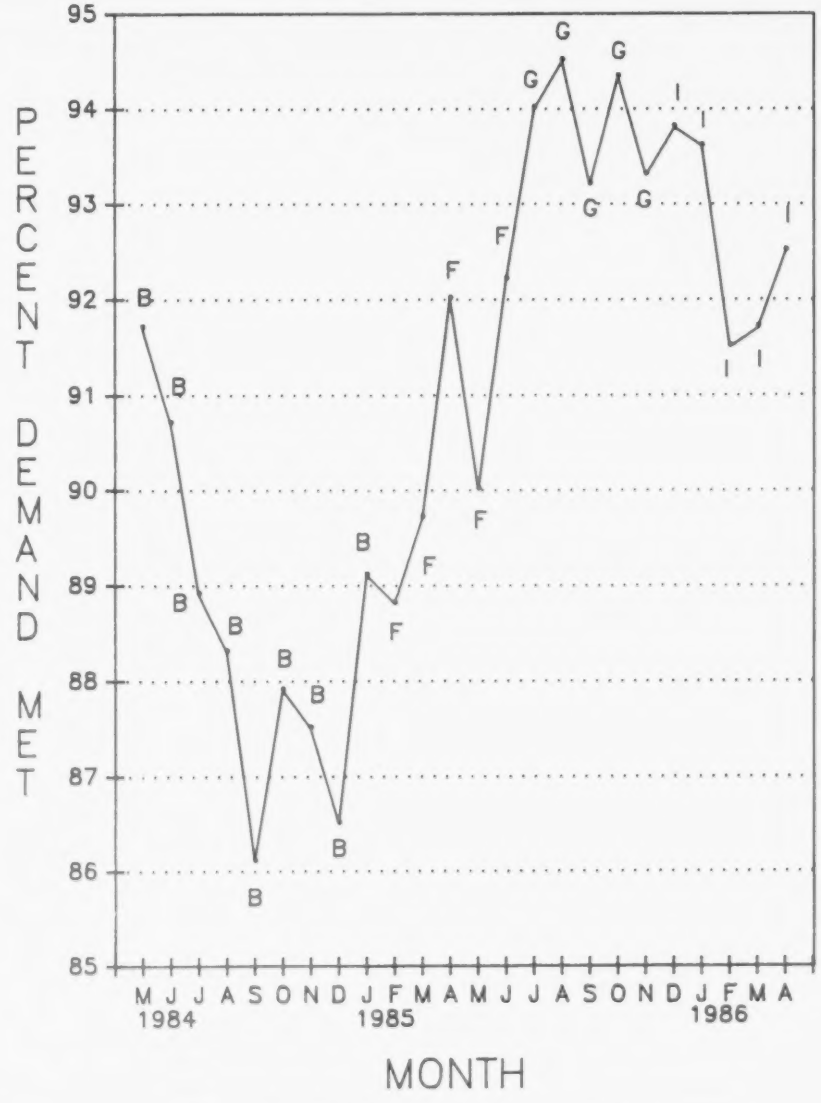


FIG.18 COMM/NAV PERCENT BOUNCES

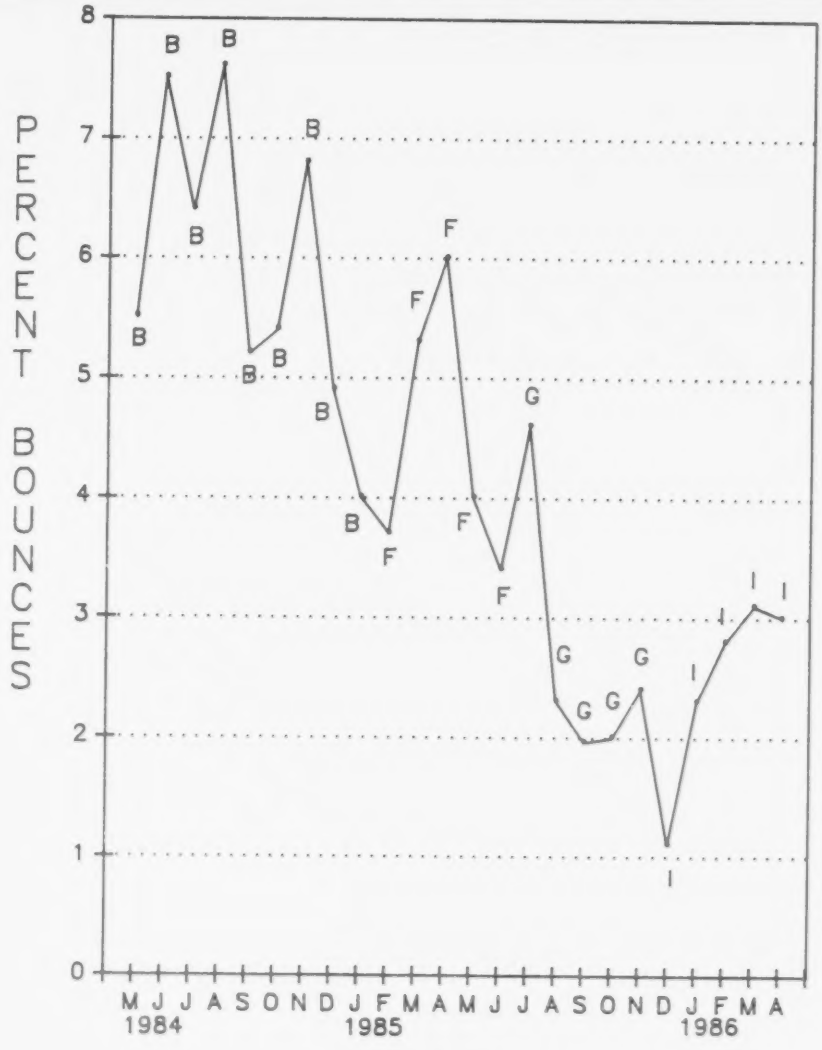


FIG. 19 RECEIVING DELIVERY TIMES P2'S

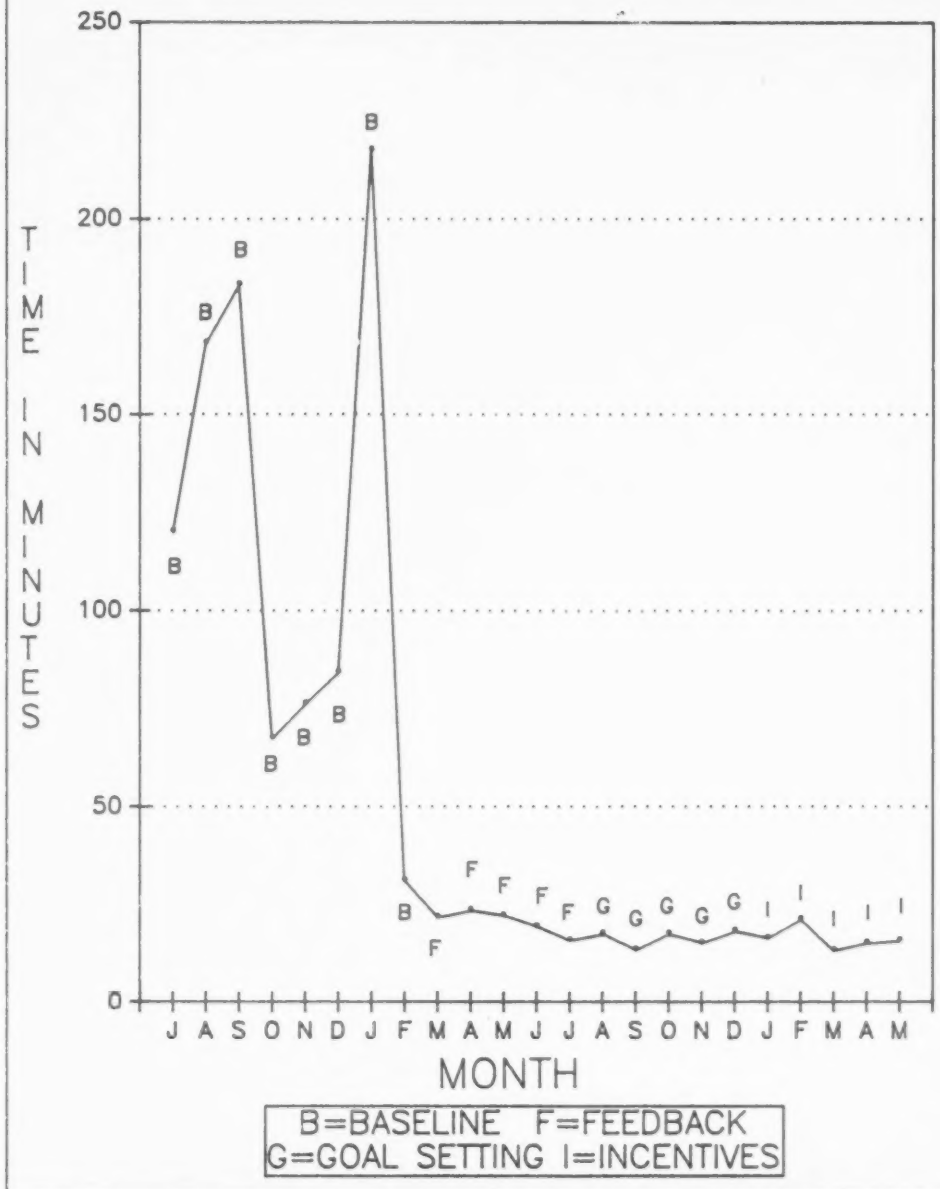


FIG. 20 STORAGE & ISSUE DELIVERY TIMES P2'S

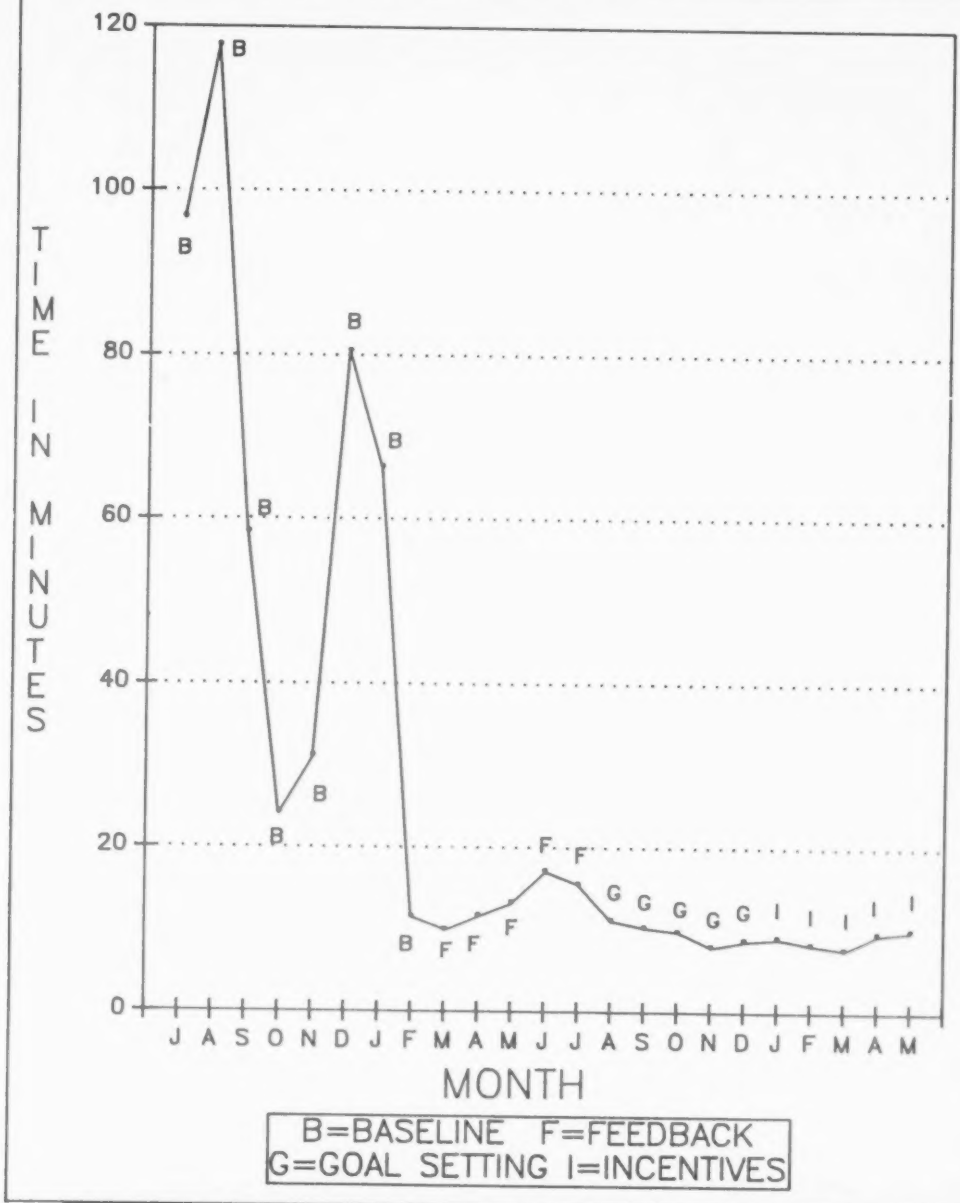


FIG. 21 PICKUP & DELIVERY DELIVERY TIMES P2 ISSUES

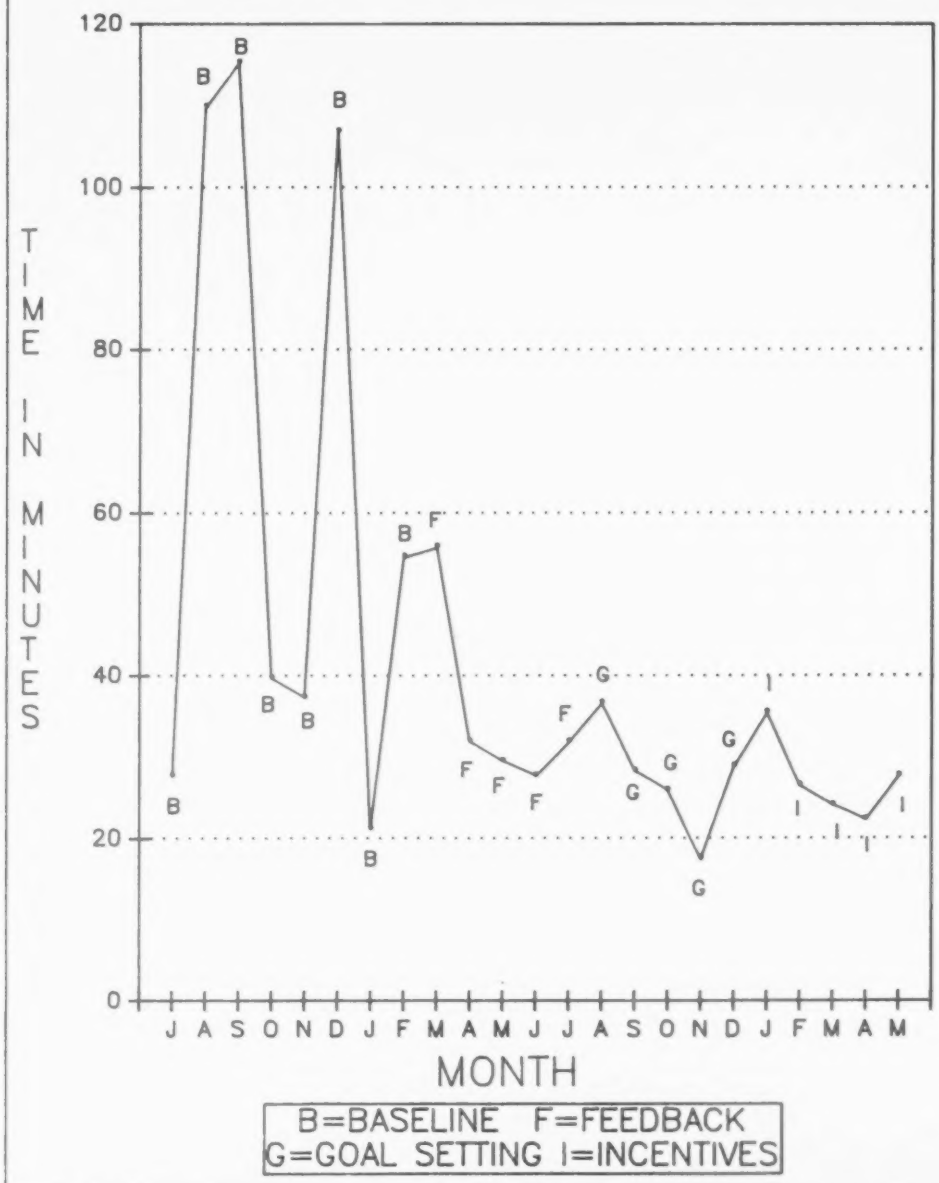


FIG. 22 INSPECTION AIRCRAFT PARTS

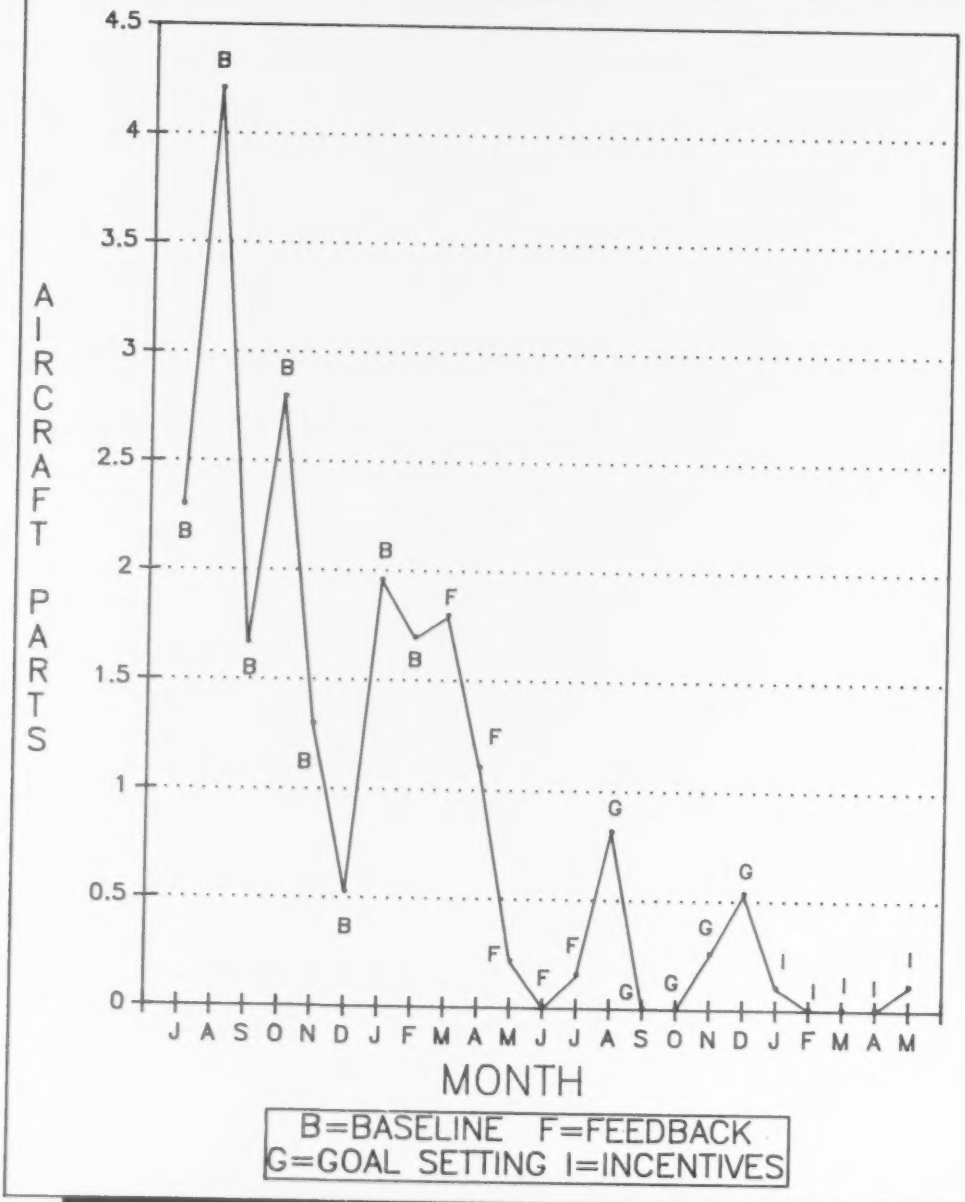


FIG.23 AVERAGE EFFECTIVENESS BY TREATMENT

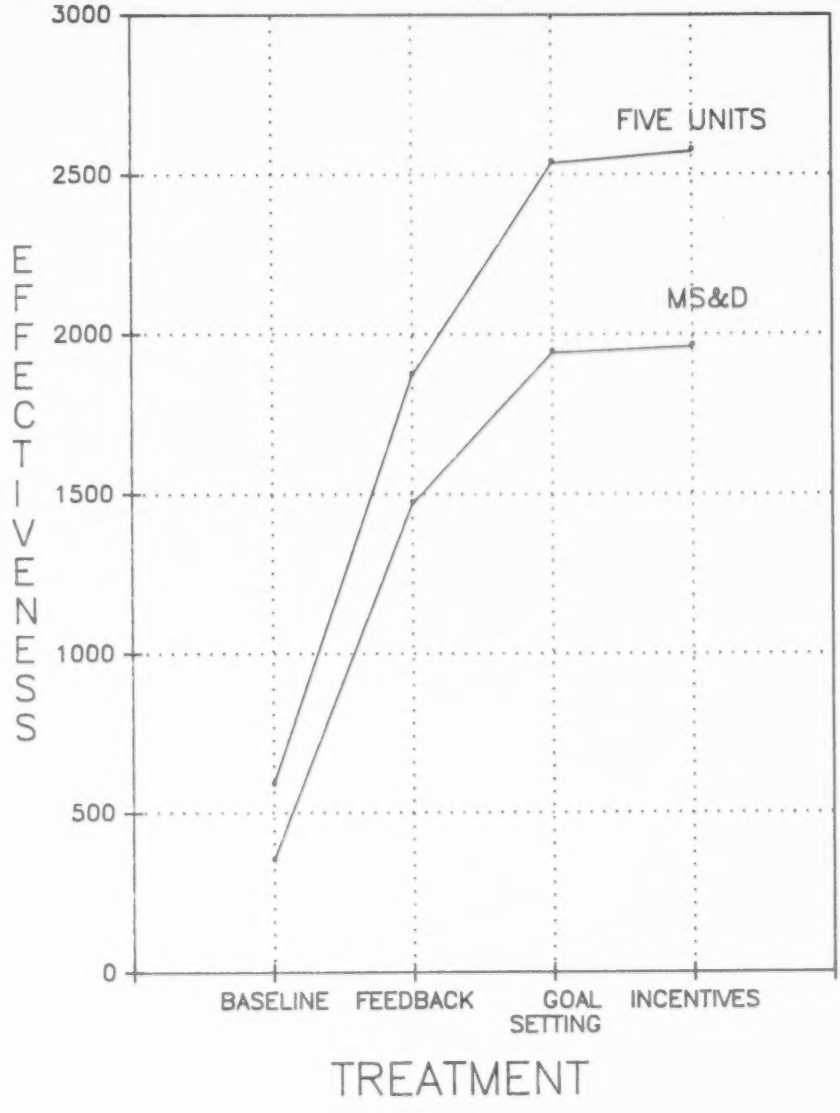
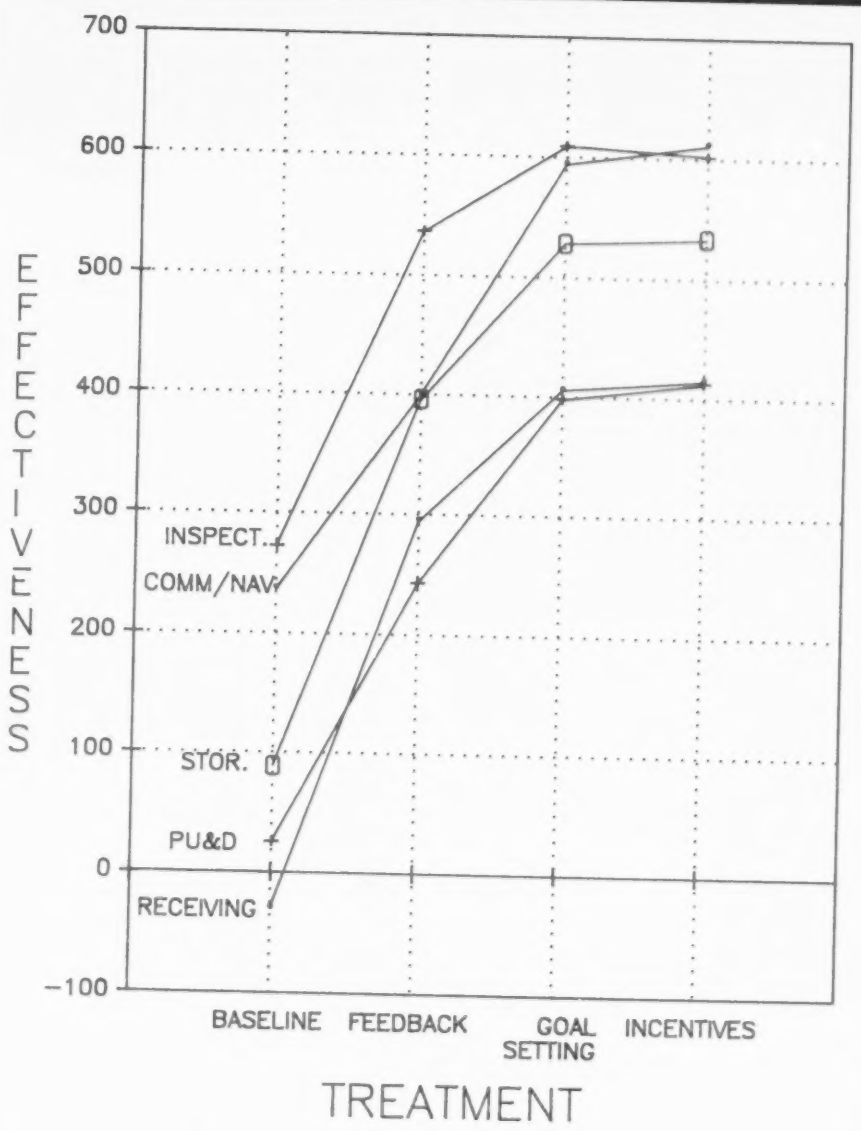


FIG.24 AVERAGE EFFECTIVENESS BY TREATMENT—FIVE UNITS



It is clear from Figures 23 and 24 that a very consistent pattern resulted. There was a major effect due to feedback, a smaller but still large further increase during goal setting, and either no increase or a very small additional increase during incentives. It is tempting to conclude that feedback increased productivity, goal setting increased it considerably more, and incentives have little additional effect. However, we do not believe this is the correct interpretation. The continued effects of feedback and ceiling effects must be considered in the interpretation of the results. These issues will be addressed in the Discussion section of this paper.

It is also instructive to examine what the units did in terms of goal setting and incentives. The goal setting data over the ten months of goal setting are presented in Table 4. Difficulty of the self-set goals varied considerably across the five units. This can be seen by the first column of the table, which indicates the number of goals (out of the ten possible) where the section's monthly goal was set lower than productivity had been for the previous month. The values range from zero for the Receiving and Inspection sections to eight for the Storage and Issue section. Goal difficulty can also be seen from the second column of the table, which shows how each section's monthly goals compared with their previous month's goals generally. That is, if the unit set monthly goals that were, on the average, 10% higher than their last month's productivity, the tabled value would be 110. As can be seen, most of the units set goals higher than their previous months' productivity. The one exception was the Storage and Issue section, which generally set goals about 5% below their productivity for the previous month.

This difference in goal difficulty is also reflected in the third column of the table, which presents mean percentage of goal attained. If, on the average, the unit's productivity equaled its goal, the value would be 100; if productivity exceeded the goal, the value would be above 100. The fourth column shows the number of months in which each unit achieved its goal. Both of these columns indicate that the Storage and Issue section fairly consistently exceeded its goals; Comm/Nav did so almost as well, and the rest of the units exceeded their goals less frequently.

The data indicate that all the units except Storage and Issue were generally setting goals that actually represented increases in productivity. Even though there were several months when units set goals below their previous month's productivity, it was expected that for some months this would be necessary. This usually occurred when a unit expected some change in workload or resources for the upcoming month. For example, if Pickup and Delivery had a driver on leave for the month, they would lower the goal for that month.

Table 4. Goal Data

UNIT	Number of Goals Set Below Last Month's Productivity	Mean Percent Goal Was of Last Month's Productivity	Mean Percent of Goal Attained	Number of Times Goal Was Attained
Comm/Nav	2	100.9	102.5	6
Receiving	0	103.2	97.2	2
Storage & Issue	8	94.7	106.8	8
Pickup & Delivery	4	101.1	99.7	3
Inspection	0	102.9	99.4	3

The results also suggest that the goals that were set were fairly difficult ones in each unit except Storage and Issue. Although the percent increase over the past month's productivity may seem low, this number includes those goals that were set below the past month's productivity due to workload or resource changes. In addition, all the units were producing at nearly their maximums, especially during the last five to eight months of goal setting. Thus, even a small increase in productivity was difficult to achieve.

Although Storage and Issue set substantially lower goals than did the other sections, this did not seem to have a negative effect on their productivity. Their percentage productivity increase over baseline during goal setting was 80%, compared to an increase of 77% for all four sections of MS&D combined. When incentives were added to goal setting, their increase was 81% over baseline, while all of MS&D showed an increase of 79%.

The incentive treatment was instituted for five months. During that time the frequency of earning incentives varied considerably among the units. Comm/Nav received time-off least frequently. They received one half day and one full day over the five opportunities. The Receiving section and the Storage and Issue section each earned two half days and three full days off. Pickup and Delivery earned three half days and two full days. Inspection earned four full days and no half days. When time off was earned during a given month, the units took that time off during the following month. If Comm/Nav, for example, earned time off for their February performance, they would take it sometime in March. This applied to all units except Pickup and Delivery. This unit was undermanned and could not take their time off in the typical manner. Instead they took the time at a later date when the work load was less.

Another point of interest relates to the way goal setting was conducted under the incentive system. Recall that goal setting was continued independent of incentives. Thus, as part of the incentive treatment, there was a level of overall effectiveness established for the full and half days off; at the same time, there was a level of overall effectiveness set by each unit as a goal. We wondered whether the goal setting would be superseded by the incentive system; that is, whether the units would merely set goals at a level that would enable them to obtain one of the two incentives. Comparison of the goal data with the incentive levels indicates that there was no tendency for the two interventions to converge. The goals that were set were independent of the incentive levels. Out of the 25 opportunities (5 units x 5 months) only 3 goals set by the units matched either of the incentive levels. In addition, observation of the goal setting sessions suggested that the goals were being set independently of those levels required for the incentives.

Also, there was no identifiable pattern to the goals in relation to the incentive levels. In 8 of the 25 possible occasions, the goals were set above the highest incentive level (that needed to earn a full day off). In 10 of the 25 occasions, the goals were set below the lowest incentive level (that needed for a half day off). For the remaining 7 occasions, the goals were set at or somewhere between the level needed for the half day and full day off.

Attitude Data

Data were also collected on work attitudes. A questionnaire was administered to incumbents and first line supervisors in each of the units. It measured job satisfaction, turnover intentions, morale, individual role clarity, clarity of objectives, and evaluation clarity. Job satisfaction was measured by seven items adapted from the Minnesota Satisfaction Questionnaire (Weiss, Dawis, England, & Loftquist, 1967). The actual items used for this and the remaining scales are listed in the appendix. The items for the morale scale were adapted from Institute for Survey Research (ISR) instruments (Seashore, Lawler, Mirvis, & Cammann, 1983). Items for individual role clarity were adapted from a Rizzo, House, and Lirtzman (1970) instrument to assess how well individuals believed they understood their roles within the organization. Items for turnover intentions, clarity of objectives, and evaluation clarity were developed for this project. The clarity of objectives portion was designed to determine how well individuals believed they understood individual and organizational priorities. Finally, the evaluation clarity portion was designed to assess how well they understood how a particular degree of productivity might be evaluated by a supervisor.

The questionnaire was administered four times: during baseline, and again at the end of each treatment. Internal consistency reliability was assessed using Cronbach's alpha (Nunnally, 1978) calculated for each scale based on the data from the first administration. Internal consistencies were good for job satisfaction (.82), morale (.86), and for role clarity (.87). They were somewhat lower for evaluation clarity (.76) and for clarity of objectives (.64), and quite low for the two-item turnover intention scale (.39).

The treatment results are presented in Table 5. The means for the four conditions were analyzed with a one-way ANOVA, with the four administrations serving as a between-groups factor. A repeated measures analysis was not used since the number of individuals for all four administrations was very small. The means for each treatment are indicated, along with the Ns, the p-value for

Table 5. Attitude Data by Treatment

SCALE	Baseline	Feedback	Goals	Incentives	*p*	MSW
Job Satisfaction						
Means	23.48	25.33	24.23	22.82	.05	25.86
Ns	60	70	56	45		
Turnover Intentions						
Means	6.9	6.7	6.7	7.0	.92	6.02
Ns	70	71	54	47		
Morale						
Means	5.42	6.90	6.55	6.47	.01	7.67
Ns	74	72	55	47		
Role Clarity						
Means	9.70	9.76	9.58	9.33	.73	4.53
Ns	73	72	55	48		
Clarity of Objectives						
Means	8.32	8.68	9.25	8.54	.08	4.25
Ns	73	72	56	48		
Evaluation Clarity [1]						
Means	7.13	6.20	4.79	5.11	.005	14.05
Ns	67	55	48	36		

1. The lower the mean, the greater the evaluation clarity. For all other scales, the higher the mean, the more positive the attitude.

the between-administrations factor, and the mean square-within (MSW) error term for the between-administrations significance test.

The results indicate that the measures of turnover intentions, individual role clarity, and clarity of objectives showed no significant changes, although the means for clarity of objectives became more positive, and the change was close to significant ($p = .08$). Job satisfaction, morale, and evaluation clarity became significantly more positive. In general, the data indicated that job attitudes under the treatments were as favorable or more favorable than before.

Effects After The Departure Of The Research Team

Once the five-month incentive treatment was over, our on-base responsibilities officially ended. Although we were on base for a variety of purposes after this time, the units had no commitments to continue the system. To explore effects after our departure, we shall address the units' attempts to change the system, our training of unit personnel to take over the system, the units' ability to run the system after we left and, finally, the productivity scores attained since we left.

A significant indication of the value of the system is that each of the five units elected to continue the system after the researchers left. This meant that they would have to commit their own resources to put together the indicator data and run the programs producing the feedback reports. In addition, we were asked by both Comm/Nav and MS&D managers to develop the system in other units in their respective squadrons. Although we did not have the resources to do so, it did indicate the value that the units placed on the system.

At the end of the formal incentives treatment, units were asked if they wished to modify the system. If they did want to, we would be there to assist if it became necessary. Comm/Nav and two sections of MS&D elected to make changes. In all three cases, the changes were made to eliminate indicators from the system. The indicators that were removed were either: ones with very flat contingencies, indicating they were not very important; activities that the units were no longer going to perform; or indicators that were under such good control that they no longer needed to be measured.

A major strength of the system is that it can accommodate changes readily. As changes occur in policies, procedures, or resources, changes will need to be made in the system. This can be done by eliminating indicators, redefining them, or altering the scaling of contingencies. Thus, the system can easily be altered to changing conditions. However, it must be understood that after such

changes are made, the new effectiveness scores are no longer comparable to the old scores. For example, if indicators are dropped, the same actual productivity will show up as lower overall effectiveness since some effectiveness points are lost due to the deleted indicators. This makes the interpretation of effects over time difficult until a new "baseline" is established. A new baseline is established by taking the newly revised system of indicators and contingencies, and calculating its overall effectiveness for several months prior to the revision. For example, if some indicators are dropped, it is a straightforward matter to go back to the indicator data from prior months and calculate what overall effectiveness would have been if those indicators had not been included. This then becomes the new baseline, and the effectiveness scores after the change can be compared directly to this new baseline. If indicators are added, it is a matter of recalculating what the overall effectiveness for prior months would have been had these indicators been included. This is a simple matter, provided historical data are available.

One feature of the system that needed to be explored was whether the units would be able to use the system after the researchers left. As part of that process, the units needed to be able to make changes in the system, since the need for changes would undoubtedly occur in the future. Thus, we were particularly interested in their ability to do this. In making these changes, it became clear that the management of the units understood the details of the system fairly well, and with help from the research team were able to make the changes. With this help, they were able to eliminate the indicators they wished, adjust the calculations of effectiveness to take the removal of the indicators into account, and recalculate past effectiveness to establish a new baseline. Our assessment was that Comm/Nav could make such changes completely on their own, and MS&D could do so with some assistance.

Before we left the base, the units wanted us to train them to use the system, so that they could continue using it after we left. This proved to be a fairly simple task in Comm/Nav. By the end of the incentives treatment, they had already taken over the collection of all the data that went into the system. They had only to be trained to use the microcomputer programs designed to calculate effectiveness scores and generate the feedback reports. This was done readily, and other than an occasional question, they operated the system completely on their own.

The training in MS&D was more involved. Although their intent to take over the system had been frequently expressed for some time, the actual commitment of personnel was not made until the end of the incentive treatment. Thus, the training could not be done gradually over many months, as would have

been optimal. In addition, the task of preparing the feedback reports in MS&D was more difficult than in Comm/Nav. The MS&D reports required the entering of data showing the amount of time it has taken to move property in the warehouse. Someone must take several hours each month to enter these data and run the program that calculates the mean times for the indicator data. During the interventions, this was done by the research team. After our departure, it had to be done by MS&D personnel. Thus, they had to learn how to enter these data and run the program, and also learn how to generate the feedback reports. Because of these factors, it took longer to train MS&D to take over the system, but as of this writing they had taken over the system completely.

A final consideration here is what happened to productivity after the units took over the system themselves. The results are shown in Figure 25. This figure not only indicates the effects after the units took over system operation, but also demonstrates the capability of the system to generate a new baseline when changes in the system are made. Since both Comm/Nav and some sections of MS&D had deleted indicators from the system, we had only to recalculate the overall effectiveness scores back in time in order to develop a baseline for comparison. In this case, all changes in the system were made the month following the incentive treatments, when our involvement in the interventions ended. To develop a baseline, we recalculated the overall effectiveness data for the five months of incentive treatment. This *adjusted* score is the overall effectiveness score that the units would have had during the incentive treatment if they had been under the revised system.

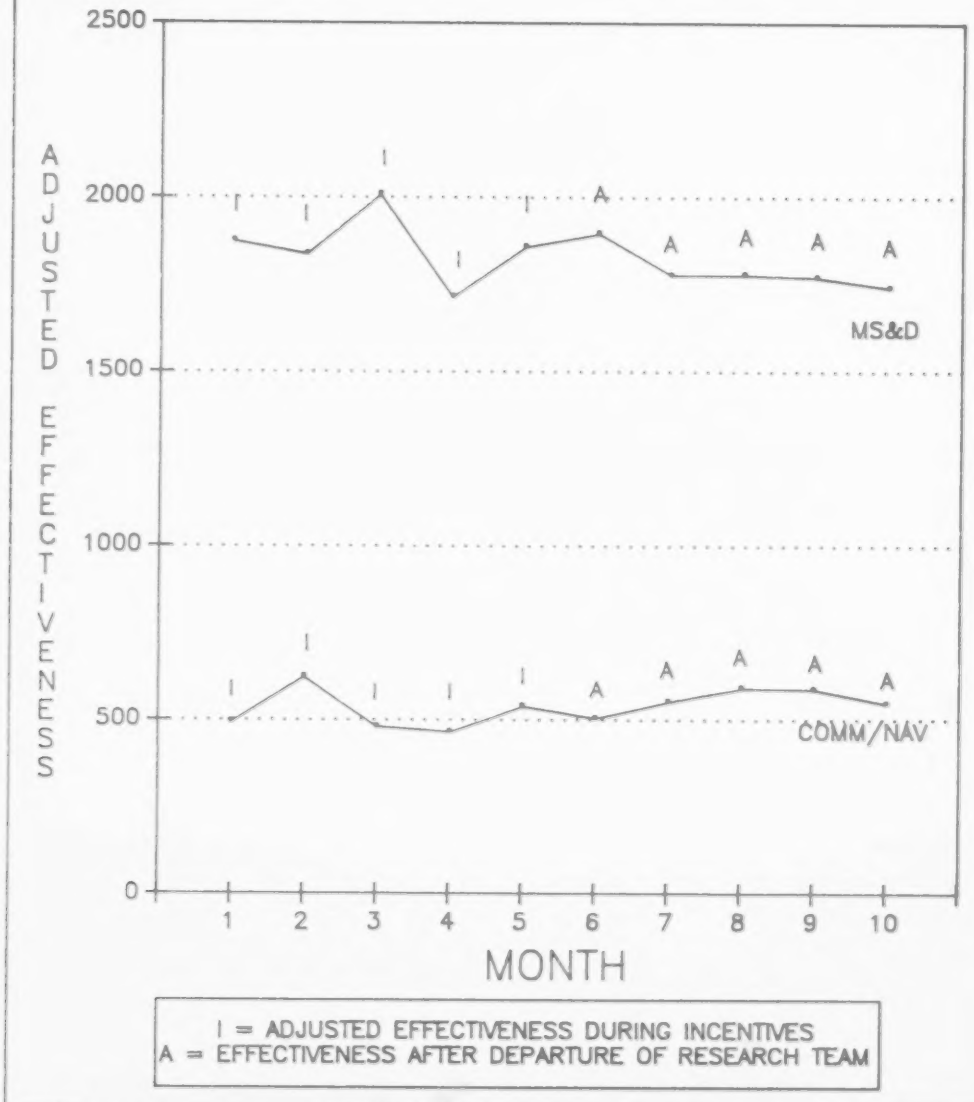
Based on the revised system, the mean overall effectiveness score under incentives for Comm/Nav was 519, and the mean after they took over the system was 556. For MS&D, the mean under incentives was 1857, and the mean after they took over was 1792. For both units combined, the respective means were 2376 and 2348 during and after incentives, respectively. Thus, the data indicate that productivity remained approximately as high after base personnel had responsibility for the system as it had been when the system was operated by the research team.

IV. DISCUSSION

The objectives of the present research were presented earlier in this paper as a series of research questions. We will repeat these questions and present the results pertinent to each.

The first research question was whether the productivity measurement system could be effectively developed in an Air Force organization. The system

FIG. 25 PRODUCTIVITY AFTER THE DEPARTURE OF THE RESEARCH TEAM



appears to be a very effective way of measuring productivity in the Air Force. Its implementation is quite feasible, unit personnel were cooperative in developing the system, and it showed good psychometric properties. In addition, system development itself seemed to have a positive effect on unit functioning even before feedback was instituted.

Finally, the system appeared successful in aggregating productivity measures across units so that an integrated system could be developed across the four sections making up a branch. This process is actually quite simple once the basic system is developed in each section. The application of this aggregation to much larger and more complex organizational units seems quite feasible.

The development of the system and its positive effects worked well on units that were quite different from one another. The units differed greatly in the nature of the work, with Comm/Nav doing repair of sophisticated equipment, and MS&D operating a large warehouse. The technologies were quite different between the two units, as well as between the four sections of MS&D. There were also great differences in the type of organizational structure and the work flow. The units varied considerably in size and the personnel varied considerably in academic as well as in technical education. They also differed in their initial levels of performance. Yet with all these differences, the system was developed and worked extremely well in each unit. This adds considerable support to the generalizability of the approach.

The second research question was whether using the feedback resulting from the productivity measurement system would increase productivity. Feedback had a very strong effect on productivity. An average gain in productivity of 50% occurred across the five units during feedback. This increase occurred with either no change or a decrease in manpower. Competing explanations for the positive results, such as Hawthorne effects, increases in manpower, and increases brought about by other organizational changes, can be ruled out.

The third research question was whether goal setting and incentives would increase productivity over feedback. At first inspection, the answer seems to be that goal setting adds to feedback, but incentives add little beyond feedback plus goal setting. This impression is based on the overall changes in productivity, where feedback resulted in a gain in productivity of 50% over baseline; feedback plus goal setting, 75%; and feedback plus goal setting and incentives, 76%.

We do not, however, believe that this is the correct interpretation. Inspection of Figure 7 shows that across the five units, there was a large change when feedback was instituted. The early months of feedback showed a very

strong improvement in productivity. This improvement then began to slow down, and finally, the curve flattened out during the last months. The negatively accelerated curve from the start of feedback to the end of incentives looks very much like a learning curve. This suggests that what may have been happening was that the units were continuing to learn how to improve productivity solely on the basis of the feedback. The possibility exists that the same amount of increase over time would have occurred if only feedback had been used. One bit of supporting evidence for this interpretation is that there was no jump in productivity at the institution of either goal setting or incentives. One would have expected a noticeable increase in the month these systems were started if they were indeed adding much to productivity.

A second and very different interpretation has to do with a ceiling effect. One could argue that since the units were near their maximum possible levels of overall effectiveness by the second month of goal setting, further increases were not really possible. Thus, both goal setting effects and incentive effects would have been stronger if there had been more room for improvement. Although this interpretation is possible, a counter argument would be that if productivity can be increased to its maximum with only feedback or feedback plus goal setting, incentives are simply not necessary. It is also possible, however, that goal setting and/or incentives would be necessary to sustain the high levels of productivity over time.

There is no conclusive way of deciding among these different interpretations of the data. The only way to make such conclusions would be to replicate the study using a much longer period for each treatment. Our own best estimate is that goal setting added somewhat to feedback, but not a great deal, and that incentives did not add further. This conclusion is based on the learning curve shape of the productivity data, the lack of a jump in productivity at the institution of goal setting and incentives, and the subjective impressions of the unit members.

The fourth research question was whether the system would change work attitudes. The results indicate that work attitudes either improved or stayed the same across a series of attitude dimensions.

A fifth research question was whether the system would be seen as valuable to the users. Clearly, it was. Attitudes toward the system ranged from positive to very positive. The members of the units were quite proud of the system and their improvements. As one indication of this, unit members frequently showed the system to people visiting the unit. In addition, by the end of

the experimental period, all of the units continued using the system on their own, and the managers of all the units wanted to expand it to other units.

The final research question was whether the system would operate successfully after the departure of the research team. The system has operated successfully, at least for the five months for which we have data at this writing. Unit personnel learned to operate the system successfully, they have continued its use, and the units have continued to maintain their productivity at the highest level that it reached during the interventions.

VI. CONCLUSIONS

A number of conclusions can be drawn from this research. First, we will discuss specific research conclusions concerning the capabilities of the system. We will then present our conclusions concerning the productivity measurement system development process, and conclusions drawn about implementing feedback, goal setting, and incentive interventions.

Conclusions About Productivity Measurement System Capabilities

The productivity measurement system that was evaluated in the present effort seems to be a very successful method of measuring productivity in Air Force organizations. Its use as the basis for a feedback system produced very large increases in productivity. Whether goal setting adds to productivity beyond feedback alone is not clear. Essentially, incentives did not increase productivity above feedback plus goal setting. The productivity interventions produced either an improvement or no change in various job attitudes. The units liked the system, and continued to use it with equal success after the departure of the research team; their high productivity has been maintained. Specifically, the positive productivity results continued for the 15 months that the research team was present on base, and have continued for at least 5 months after that.

The development and application of the system also has a number of added benefits. It allows for the direct comparison of the productivity of different units to each other. It can be used with both effectiveness and efficiency approaches to productivity. In addition, it can be applied to any level of the organization, allows for competition among different units, helps identify the priorities for increasing productivity, and serves as an excellent basis for evaluating any changes made in the organization.

Conclusions About the Process of Developing Productivity Systems

In doing this research, a number of conclusions were drawn concerning the process to be used for developing productivity measurement and enhancement programs in Air Force environments.

One is the importance of having the personnel who are going to be using the system be heavily involved in its development. The perception of unit personnel was that some previous programs imposed from above had not been effective because these programs were not designed with an appreciation for their unique needs and environment. It is much more effective to have heavy involvement from the personnel that are going to use the system so that the final product will fit their needs and they do not feel that it is yet one more project imposed from above.

It also seems more effective to develop such programs from the bottom of the organization up. The lower levels of supervision know the most about the functioning of the unit, the real critical issues, what are reasonable goals, and what are attractive incentives. In addition, these are the people that will make the system work. It is important to have their involvement and knowledge from the start. It is also important to have higher-level involvement to approve the system. This should be done as the measurement system is being developed, not delayed until the system is complete. We believe the technique of getting approval on products and indicators before starting contingency development proved very valuable. It not only helped clarify policy earlier in the process, but also helped prepare everyone for the eventual implementation. This approach gave all levels of the organization a chance to learn about the system as it was being developed so that they would know how to use it when it was finished. It also served to generate considerable eagerness at all levels to receive the first feedback from the system.

We also learned the importance of using a multiple meeting structure that allows for an iterative approach to the development of the system. Our strategy was to summarize the results of each meeting and present them at the next meeting to assure consensus was reached. In this way, unit personnel had time to think about the issues, discuss them among themselves, and be prepared to approach the question with fresh perspectives at the next meeting. Personnel need time to adjust to the idea of completely capturing what they do in a productivity measurement system. They need to think about how to structure a feedback report, how many levels of incentives to use, etc. They need to consider what the implications are, and be able to discuss the issues among themselves thoroughly.

We believe that a high quality system such as this could not have been built without multiple meetings separated in time.

It also proved very effective to have unit personnel who developed the measurement system defend it when it was presented to higher management. They were much more knowledgeable than the researchers about the subtleties of unit operation, and could better address management's questions and concerns. Also, it gave them a chance to present their perceptions of optimal policy. Finally, their sense of ownership of the system was increased by their defense of it.

Care must be used during development to ensure that the resulting indicators are measures which are under the control of the unit (Hurst, 1980). The researchers frequently needed to remind unit personnel to assess whether they had control over a given indicator. Unless the unit has full control over the work being performed, including measures of performance on that work would be counterproductive in that they would decrease the motivational impact of the system.

It is also important that the researchers develop good rapport with the operational personnel. Some personnel were initially suspicious of our intentions, and had questions about our credibility. Their experience had been that outsiders, who were not experts on their operations, had sometimes imposed programs that at best resulted in extra work, and at worst had a negative impact on their effectiveness. Taking the time to really learn what they did, and getting to know them, went a long way toward decreasing these barriers.

Implementing Feedback, Goal Setting and Incentives

During implementation of the feedback, goal setting, and incentive interventions, several issues came up that are issues for future implementations of these techniques.

During feedback, we noted that management in some cases seemed to focus much more on small amounts of negative productivity information rather than on the much larger amount of positive information. For example, in some meetings where the feedback reports were discussed, a manager would focus on the few areas where the unit decreased in effectiveness, and largely ignore the majority of areas where productivity had improved or was quite high. This had the effect of making those meetings a somewhat punishing experience for unit members, rather than a positive experience. It is important that management be trained to conduct these meetings so that they will give recognition when it is

due, and so that the positive and negative information are given appropriate emphasis.

It is extremely important that programs such as those used here have higher management support. This is very important for the continued operation of the program. In this regard, it is very important that senior management be kept informed about the program and fully understand it.

We did not anticipate the difficulty of keeping higher management support of the project when there was turnover in these management positions. There was generally an initial resistance to the program by the new manager. In retrospect, this is not surprising. The program was not developed by the new manager, and he/she did not have a sense of ownership of it. Therefore, it is very important to take considerable time with the new manager so that he/she can be convinced that the program is indeed a sound one.

There were also several issues associated with goals and incentives. We have already discussed the issue of "reportable" and "non-reportable" goals, the importance of participation in the design of the system, and the importance of joint supervision and incumbent participation in setting goal levels. For incentives, we have discussed the importance of the number of incentive levels to be used and of ensuring equity across units in what it takes to obtain the incentives.

Another issue regarding incentives is that one should expect resistance to the use of incentives, especially from supervisors. In the present effort, we encountered considerable resistance from supervisors. The major point made by those who were opposed to incentives was that Air Force personnel should not be rewarded for simply doing what they are already supposed to do. There was also some indirect evidence that some supervisors felt such an incentive system would undermine their power and their own prerogatives to reward individuals and units informally. In contrast, the incumbents were much more positive about the incentive system than were supervisors. Incumbents wanted the time-off, but more importantly, they wanted some tangible form of recognition for their high productivity. There were, of course, some supervisors that were in favor of incentives and some incumbents who were not. We would estimate that about 30% of the supervisors and 85% of the incumbents were in favor of incentives.

Finally, care should be taken with an incentive system to ensure that management does not increase the level of performance needed to obtain an incentive once productivity has increased. This practice could easily lead to resentment and a sense of inequity among unit personnel. In one unit, there was an attempt to do this and the research team managed to convince the manager that this could

have negative consequences. Future applications should be prepared for this eventuality.

Summary

In conclusion, the present effort has shown that productivity in units with complex Air Force jobs can be measured with this approach. The approach proved very successful in this application and has many advantages that make it attractive for other applications as well. The use of group-level feedback resulting from the productivity measurement system produced large increases in productivity, and may well have accounted for the majority of the overall productivity gain. Goal setting seemed to add to productivity, but incentives added little beyond feedback and goal setting. The interventions of feedback and goal setting clearly have a place in the techniques of productivity enhancement in the Air Force.

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APPENDIX: ATTITUDE SCALES

JOB SATISFACTION

Response Format: Five-point Likert format with anchors of Very Dissatisfied, Dissatisfied, Not Sure, Satisfied, and Very Satisfied.

Items:

1. The chance to do something that makes use of my abilities.
2. The way Air Force policies are put into practice.
3. The freedom to use my own judgment.
4. The chance to try my own methods of doing the work.
5. The working conditions.
6. The praise I get for doing a good job.
7. The feeling of accomplishment I get from the job.

MORALE

Response Format: Five-point Likert format with anchors of Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree.

Items:

1. A spirit of teamwork exists between the people in my section.
2. A spirit of teamwork exists between the people in my branch.
3. The people in the section work together to accomplish the section's objectives.
4. The people in the branch work together to accomplish the branch's objectives.
5. I feel a sense of pride at being a member of this section.
6. I feel a sense of pride at being a member of this branch.

TURNOVER INTENTIONS

Response Format: Five-point Likert format with anchors of Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree.

Items:

1. I plan to reenlist or extend.
2. I would like to leave the Air Force next year.

ROLE CLARITY

Response Format: Five-point Likert format with anchors of Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree.

Items:

1. I know what my responsibilities are.
2. I know exactly what is expected of me.
3. Explanation is clear of what has to be done.

CLARITY OF OBJECTIVES

Response Format: Five-point Likert format with anchors of Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree.

Items:

1. I understand which of my work objectives are more important than others.
2. The work objectives of my section are clear and specific.
3. The work objectives of the branch are clear and specific.
4. I understand which of my section's objectives are more important than others.
5. I understand which of the branch objectives are more important than others.

EVALUATION CLARITY

Instructions: For each situation below, please circle your estimate of the lowest and highest ratings you think your supervisor might give to you or your work group. For some of these duties you may be very sure about your supervisor's evaluations, and the "lowest" and the "highest" ratings would be very close. For other situations, you might be unsure what kind of evaluation your supervisor would give; therefore, there would be a big difference between the highest and lowest possible evaluations. Please rate what you believe your supervisor's evaluation of you and your work group would be for the following monthly performance data.

Please use the following in deciding which number to circle. (The specific items were tailored to be relevant to each section.)

1 = Worst possible 2 = Poor 3 = Below average 4 = Average
5 = Above average 6 = Good 7 = Excellent

1. On the average,	1	2	3	4	5	6	7	highest
75 percent of the unfrozen rejects were cleared in a day.	1	2	3	4	5	6	7	lowest
2. MS&D took an average of 2 hours to get all	1	2	3	4	5	6	7	highest
priority 2 DOR items to the customers.	1	2	3	4	5	6	7	lowest
3. MS&D took an average of 2 hours and 20	1	2	3	4	5	6	7	highest
minutes to get all priority 3 items to the customers.	1	2	3	4	5	6	7	lowest
4. MS&D took an average of 48 hours to get	1	2	3	4	5	6	7	highest
all priority 4 items to the customers.	1	2	3	4	5	6	7	lowest
5. There was a daily average of 100	1	2	3	4	5	6	7	highest
delinquent documents charged to MS&D per month.	1	2	3	4	5	6	7	lowest